International Marine Engineering

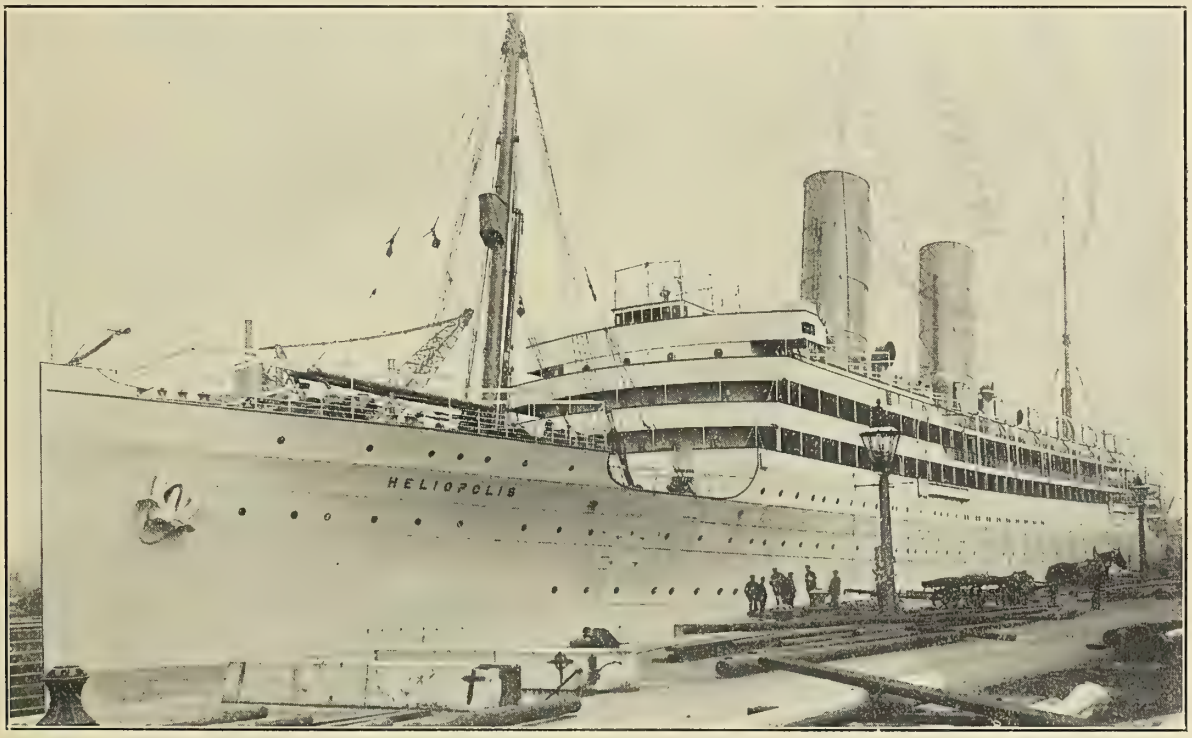
JANUARY, 1908.

NEW EGYPTIAN MAIL TURBINE STEAMSHIP HELIOPOLIS.

BY ALLAN MCPHERSON.

Built by the Fairfield Shipbuilding & Engineering Company, Limited, Glasgow, for the Egyptian Mail Steamship Company, the new turbine steamer *Heliopolis,* which was launched on May 28 last, is notable as being the largest turbine passenger steamer yet built at Fairfield.

The *Heliopolis* has three propellers, driven by three independent Parsons compound steam turbines. In the center of the ship there is one high-pressure turbine, taking steam direct from the boilers. The two low-pressure turbines are mounted on the wing shafts. The astern turbines are also on the wing shafts, inside the low-pressure cylinders. The turbine rotors are of cast steel, each in one piece, and the cylinders are each in two pieces bolted together.



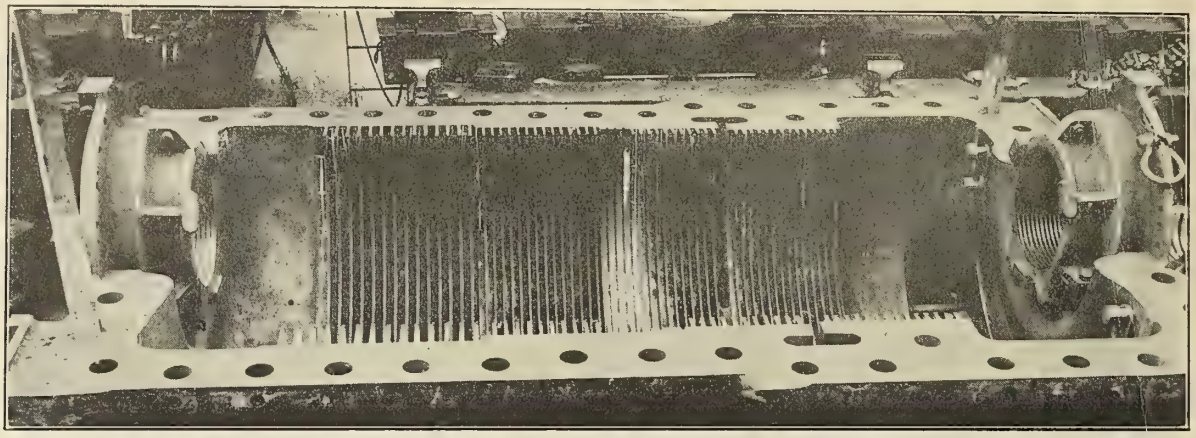
THE HELIOPOLIS IN DRYDOCK AT GLASGOW.

Grooves are cut in the rotors, into which the revolving blades are fixed, and similar grooves are turned on the inner surface of the cylinders, for the stationary blades. The blades are wedged separately into these grooves and are then bound together with brass wire of square section, which fits into a slot cut in the front edge of each blade near the top. This brass wire is laced to the blades with fine copper wire, and then soldered. The turbine blades are of rolled brass. Their length increases from the high-pressure end to the last rows, where the steam passes to the condensers. There are about a million blades in these turbines.

Our illustration of the turbine rotor gives an elevation of the blading arrangement, and, though this is a low-pressure rotor, the principle is exactly the same throughout. In the turbine, the total steam expansion is subdivided into a number of steps. The expansion of steam at any one stage is typical of its working throughout the turbine. Each stage consists of a ring of stationary blades, which gives direction and velocity to the steam, and a ring of moving blades that immediately converts the energy of velocity into useful torque. The total torque on the shaft is due to the impulse of steam entering the moving blades, and to reaction as it leaves them, this process being repeated throughout the turbine.

The turbines exhaust direct into two steel plate condensers, fitted with solid drawn brass tubes, and placed alongside the low-pressure turbines. The cooling water for condensing the exhaust steam is circulated through the condensers by four large centrifugal pumps, two for each condenser, and the condensed steam is withdrawn from the condensers by two single-acting twin air pumps.

The engine room is fully equipped with the most modern appliances, which include three large electric light engines and dynamos, three Hall's CO_2 refrigerating machines, pumps for supplying hot and cold salt water to the baths, also pumps for sanitary purposes, washing decks, for extinguishing fire and for fresh water for passengers' use. There are also bilge and ballast pumps, and these can, in the event of an accident to the

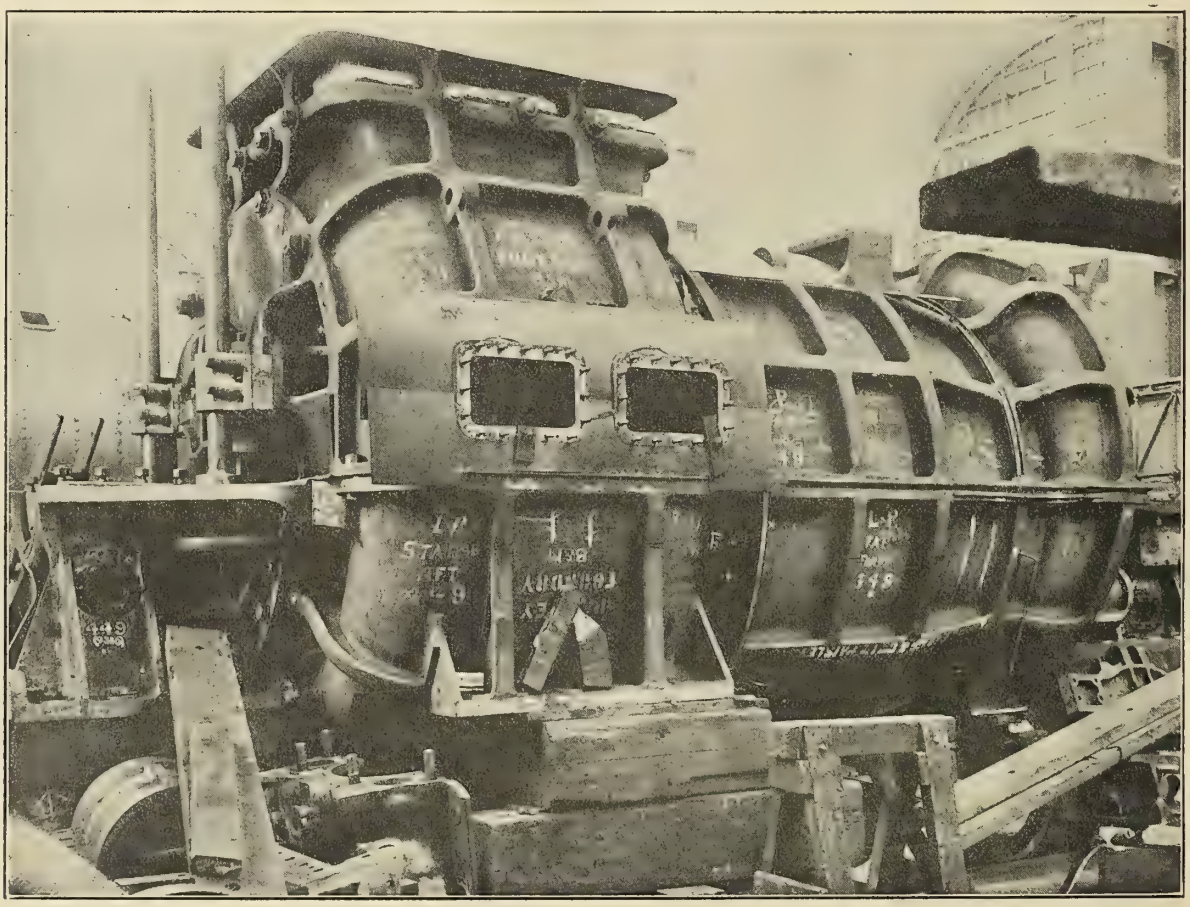


INSIDE VIEW OF THE LOWER HALF OF THE CASING FOR A HIGH-PRESSURE TURBINE, STEAMSHIP HELIOPOLIS.

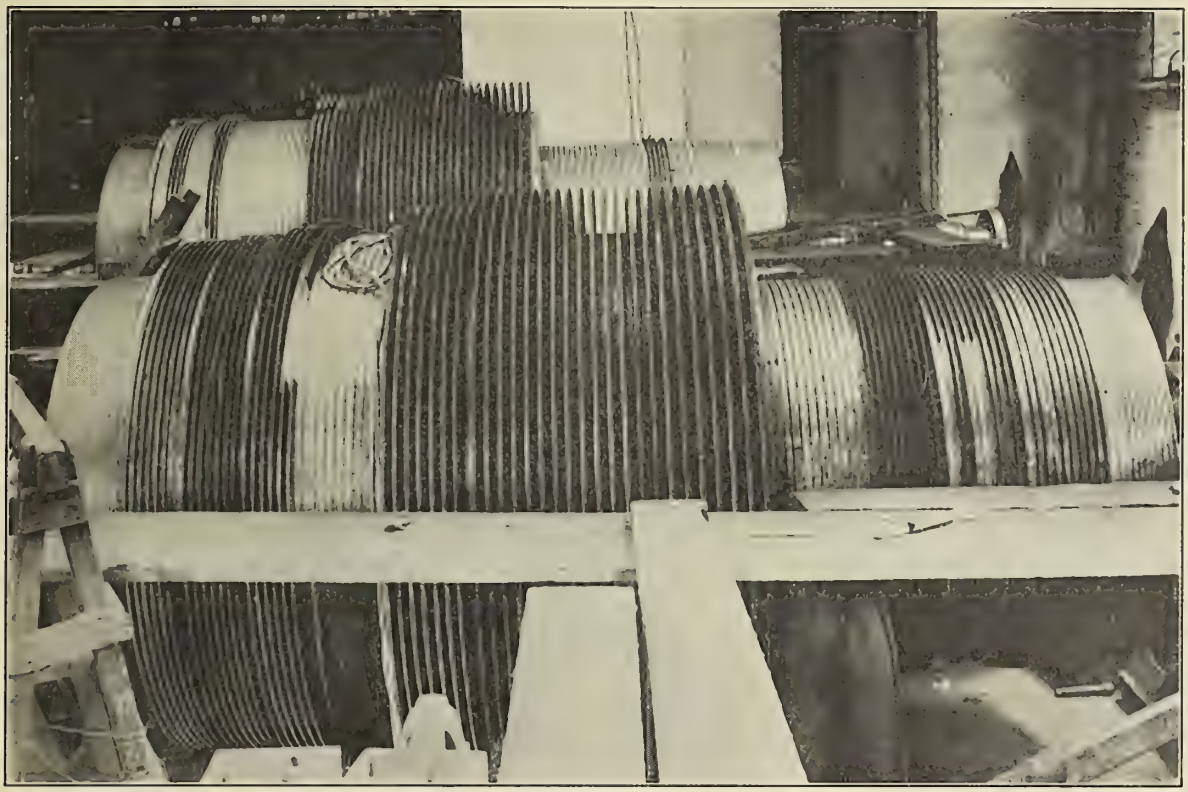
ship, be supplemented by the large circulating pumps, to discharge water from the vesel, the total capacity of these pumps being equal to fully 2,000 tons per hour. In the engine room there are also arranged four large main and auxiliary feed pumps of G. & J. Weir's design. Two gravitation feed filters of List & Munn's patent are fitted, for removing grease and other impurities from the feed water. The distilling plant consists of two large evaporators, together capable of producing from sea water 100 tons of fresh water per day, and two distilling condensers, having a combined output of 12,000 gallons of pure fresh drinking water per day.

The propellers have three blades each, and are made of manganese bronze. They are accurately machined and balanced, and the blades are carefully polished to reduce to a minimum the frictional resistance incidental to the high velocity at which they pass through the water, and which at the tips exceeds 100 miles per hour. The propellers and balanced rudder are clearly shown in our illustration. It is also noticeable that there is no outboard shafting, which arrangement is an advantage to the engineer, as shafting and bearings can be inspected at all times without the necessity of docking the ship.

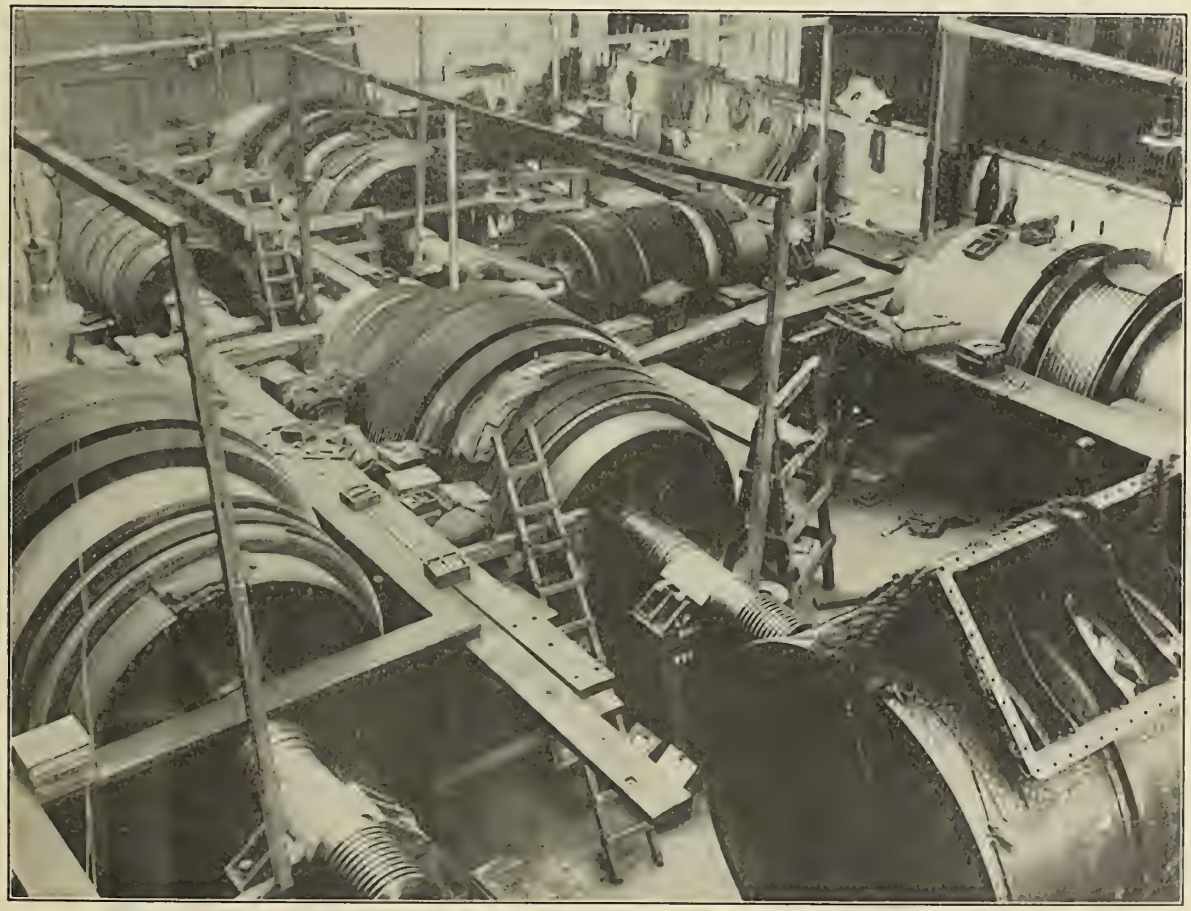
The boiler installation consists of four double and four single-ended steel boilers of the ordinary multitubular type, each working at a pressure of 195 pounds per square inch. These are arranged in two boiler rooms, and the exhaust gases pass into two funnels, which rise to a height of 1 [illegible] feet above the sea level. The boilers are arranged to wo[illegible]



ONE OF THE LOW-PRESSURE TURBINES, SHOWING THE EXHAUST NOZZLE AT THE TOP AND STEAM INLET AT RIGHT.



LOW-PRESSURE TURBINE ROTORS PARTLY BLADED. THE ASTERN TURBINES ARE AT THE RIGHT END.



GENERAL VIEW OF HIGH-PRESSURE AND LOW-PRESSURE TURBINE ROTORS IN PROCESS OF CONSTRUCTION.

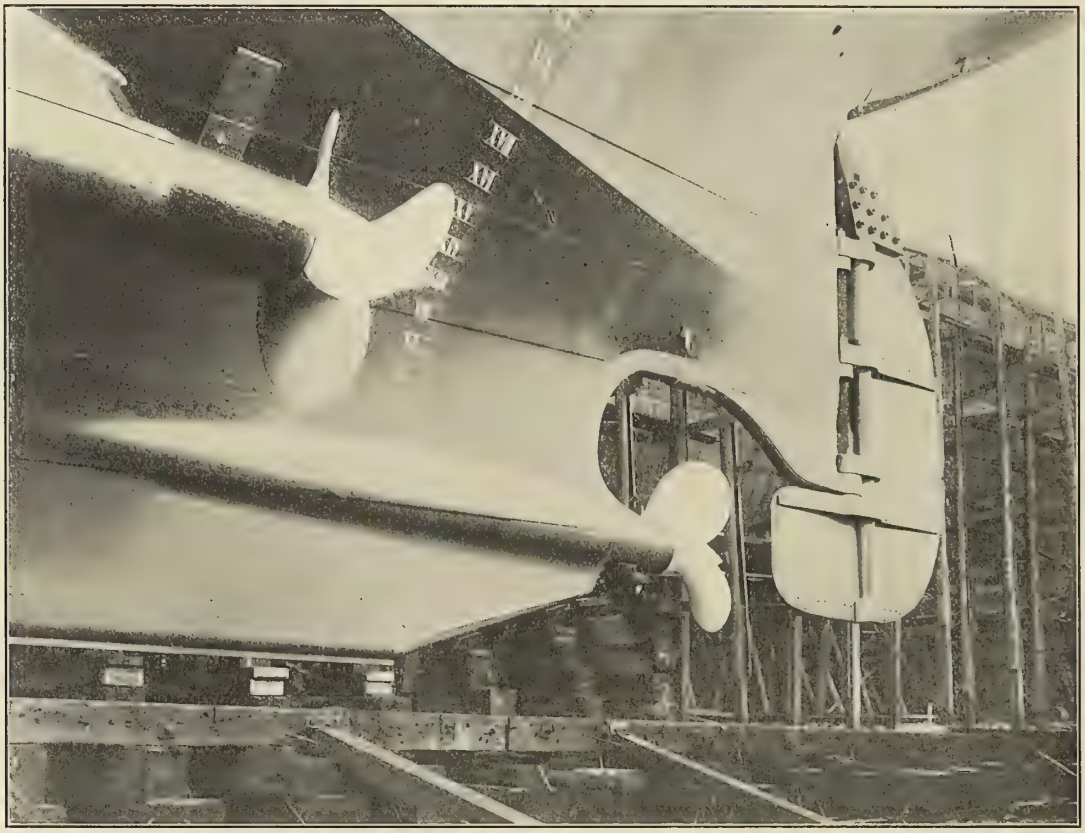
with Howden's forced draft, air being supplied by eight large fans, each driven by an independent inclosed steam engine.

The *Heliopolis* is of the following dimensions:

Length over all	545 feet
Breadth molded	60 feet 3 inches
Depth to shelter deck	38 feet
Draft loaded	22 feet 6 inches
Displacement in tons	15,000
Indicated horsepower	18,000
Speed at sea	20½ knots
Gross tonnage	12,000

a bath and toilet attached. Some of them include also a sitting room. The cabines de luxe are very large, and are fitted with wide berths, velvet pile carpets, luxurious settees and arm chairs, dressing tables, wardrobes, writing tables and book cases, and have hot and cold water supply. Electric lamp, electric bell and electric fans are fitted at convenient points for each berth, and electric fittings are also provided for heating curling tongs.

On the promenade deck amidships is the first saloon entrance. It has a handsome staircase leading to the bridge deck and from there to the shelter deck. Aft of this entrance



THE STERN OF THE SHIP, ON THE WAYS, SHOWING FORM OF RUDDER AND ARRANGEMENT OF PROPELLERS.

The hull is divided into separate watertight compartments by nine bulkheads. To further insure immunity from danger, a double bottom is fitted all fore and aft, divided by numerous watertight divisions into separate water ballast tanks. Each tank can be filled or emptied independently, so that the trim and draft of the ship can be adjusted at any time to suit the conditions of service. The total water ballast capacity is 3,500 tons. The ship is built to Lloyds three-deck and shelter deck 100 A1 class, and has seven decks, named in the following order from below: Lower, main, upper, shelter, bridge, promenade and boat deck. There are two pole masts, fore-and-aft rigged, with derricks for handling cargo.

In the passenger arrangements, the Fairfield Company has embodied the accumulated results of their long and varied experience in the designing of first class passenger ships. Accommodation is provided for 710 first class and 290 second class passengers. There are no third class passengers.

The promenade and bridge decks are entirely devoted to first class passengers. The staterooms are fitted up in a most luxurious manner. The cabines de luxe are a special feature of the ship, the ceiling and walls of each being treated differently; some are paneled in satinwood, others hung with tapestry. There are a number of these cabins, and each has

on the promenade deck is the music room, which is exquisitely finished in pure white. The furniture and grand piano are also in white. Immediately below the music room on the bridge deck is the library. This room is very large, is framed in oak, and has a handsome book case and other furniture, also of oak. Aft of the library is the first class smoke room, which is very comfortable and commodious, and well lighted, having large square windows around the sides, and a rectangular well above with ornamental fret work and provision for ventilation. The walls are framed in oak with hammered brass panels.

On each side of the promenade and bridge decks amidships there is a clear promenade of 10 feet 6 inches for first class passengers, and the bridge deck extends right aft to the stern.

On the shelter deck, and leading from the main staircase, there is the first class dining saloon. This room, which is about amidships, extends the full breadth of the vessel, and is 77 feet long. In the center of the room there are a number of round and oval tables, and at the ship's side in bays are small tables to seat five persons each. The saloon is arranged to seat 256 persons, but not more than 16 at one table. The side ports are placed in pairs close together, and have ornamental glass shutters. These, together with the large oval

dome in the center, afford splendid light to the saloon. At the fore end there is a piano, and at the after end an artistic sideboard. Forward of this saloon is a separate dining saloon for children. Aft of the first class dining saloon are the pantries, with the sculleries, galleys, bakery, confectionery, etc., forming one large kitchen, and equipped with all the most up-to-date machinery and appliances for cooking.

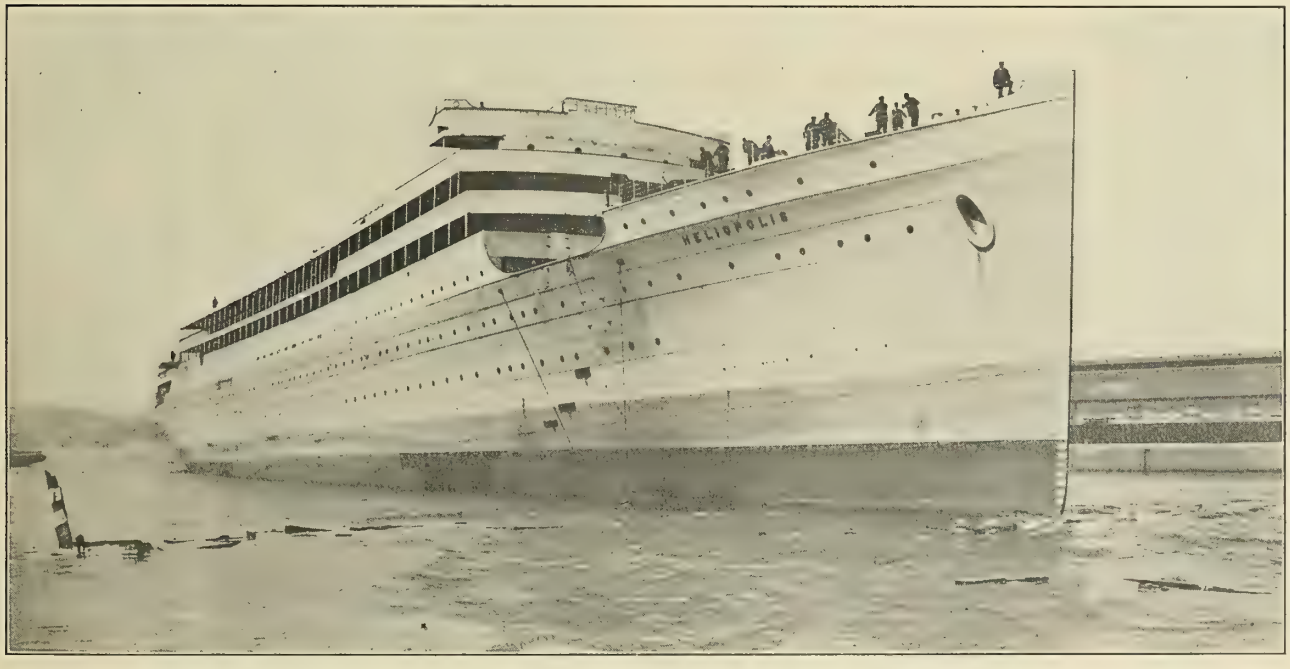
Aft of the pantries is situated the second class dining saloon. In the center are the usual long tables, and at the sides a number of tables each to seat eight persons. This saloon is 60 feet long by 50 feet broad, and is arranged to seat 180 persons. Passing through double swing doors, the second class social hall is reached. Aft of the social hall is the second cabin smoke room. This, like the first class smoke room, is arranged with cosy corners, arm chairs and small tables.

Leaving this deck and going below, the upper deck is reached, with two side passages all fore and aft, the one on the port side being reserved for the use of the ship's company, while that on the starboard side is for the accommodation of passengers. On the starboard side are staterooms, and on the port side engineers' quarters, also rooms for stewards, butcher, baker, barmen, chef and cooks, cold store rooms for ship's provisions, and a printer's shop.

The forward part of the main deck is all occupied by two and three berth cabins for first class passengers, and on the same deck aft similar cabins are arranged for second class passengers. The lower deck is all cargo space, part of it being insulated for carrying frozen meat. The mail and specie rooms are on this deck. Under the lower deck is the ship's hold.

Returning by the stairways to the main deck, and entering the hoist, the passenger is carried up to the promenade deck. On the boat deck is the café, a special feature of the latest liners. This room extends right across the full breadth of the deck-

THE STERN, JUST BEFORE THE SHIP WAS LAUNCHED.



THE HELIOPOLIS WAS FLOATED FROM THE YARD OF THE FAIRFIELD SHIPBUILDING AND ENGINEERING COMPANY ON MAY 28, 1907.

house, and is 63 feet long. It is furnished with small tables to seat four persons at each, and is capable of seating 88 persons. There are a special kitchen, scullery, larder, glass room and wine room, etc., on the boat deck for supplying café.

The officers' messing and sleeping accommodation is situated forward of the café. The wireless telegraph office is also on the boat deck.

The ventilation arrangement is a special feature of this ship, and is on the thermotank system. The installation consists of a number of large thermotanks distributed over the various decks. These tanks assimilate air from the open, and when charged can reduce or raise the temperature of the air to any degree desired. This done, the air is distributed by centrifugal fans through trunks to any part of the ship. In

addition to this system, there are electric exhaust fans in the smoke rooms and in the dining saloons.

There is a complete installation of electric light, which consists of three sets of combined engines and dynamos of compound type, Siemens & Bellis make, any two of which are capable of generating and supplying light equal to 28,800 candlepower, also supplying the necessary current for a large number of cargo lamps of 200 candlepower each, and to the thermotank motors, fans and electric passenger hoist. The current is transmitted by insulated cable, all wiring being done on the double-wire distribution box system.

The main switchboards are fitted with ammeters, voltmeter and switch, pilot lamps and switches, double pole switches and fuses for each of the generators, and change-over switches and double pole fuses for each of the main circuits. The instruments are of the moving coil type, and the whole switchboard is arranged for easy handling, each switch being distinctly marked with the name of the circuit which it controls.

The steering wheel on the navigating bridge is in direct communication with steering gear aft, on the latest telemotor principle.

Another feature of the ship is the Clayton fire extinguishing arrangement. The extinguisher is capable of generating and delivering by means of pipes to any part of the ship upwards of 25,000 cubic feet of fire extinguishing gas per hour. The machine extracts air from the compartment, simultaneously delivering sulphur dioxide into it. When the fire is extinguished, the sulphur dioxide is withdrawn by suction. By the same machine, fresh air can be simultaneously injected into the compartment. It will thus be seen that the usefulness of the machine is not confined to fire extinguishing purposes, but it may be used either for ventilation by extracting foul air and delivering fresh air, or for disinfecting any compartment in the ship.

The *Heliopolis* and her sister ship, *Cairo,* also building at Fairfield, are for the new express, mail and passenger service between Marseilles and Alexandria.

The speed trials of the *Heliopolis* took place on the Firth of Clyde from the 6th to the 9th of November. These consisted of a progressive trial of four double runs on the measured mile at Skelmorlie, and two runs of twelve hours each, one of these being at full speed. During the twelve hours at full power the mean speed was 20.75 knots, with the turbines making about 370 revolutions per minute and developing 18,000 horsepower. The contract speed was 20½ knots.

Vessel Tonnage Movement in the Principal Ports of the World.

There has been much discussion regarding the total tonnage of entrances and clearances of ships in the principal commercial ports, and claims have been made from time to time that this port or that one had the greatest tonnage movement to be found anywhere. The following statement, covering in other ports the calendar year 1904, and in New York the fiscal year ended June 30, 1905, will be of interest in this connection. The figures have been compiled by the Bureau of Statistics in the Department of Commerce and Labor, and are taken from official sources. They represent net register tons and foreign trade only, no coasting or fishing services being included:

Port.	Entered.	Cleared.	Total.
Hong Kong*	9,680,642	9,652,454	19,333,096
New York	9,630,853	9,311,527	18,942,380
Antwerp	9,373,703	9,339,707	18,713,410
London	10,788,212	7,850,947	18,639,159
Hamburg	8,681,534	8,770,675	17,452,209
Constantinople	.....	.....	15,066,621
Liverpool	7,986,584	6,730,206	14,716,790
Rotterdam	7,181,374	6,764,960	13,946,334
Cardiff	4,795,406	8,324,066	13,119,472
Singapore*	6,175,905	6,155,848	12,331,753
Shanghai	6,076,279	6,105,519	12,181,798
Colombo	5,195,822	5,154,094	10,349,916
Marseilles	5,061,912	4,645,467	9,707,379
Lisbon	4,820,940	4,783,209	9,604,149
Gibraltar	4,402,552	4,388,425	8,790,977
Funchal (Madeira)..	4,429,175	4,316,018	8,745,193

A similar statement for the calendar year 1906 shows a healthy increase in nearly all of these ports.

Port.	Entered.	Cleared.	Total.
New York (*d*).....	11,383,345	10,472,601	21,855,946
Hong Kong (*a*, *)...	9,899,049	9,879,127	19,778,176
Antwerp (*a*)	9,864,528	9,800,149	19,664,677
London	11,222,542	8,185,400	19,407,942
Hamburg (*a*)	9,408,000	9,516,000	18,924,000
Shanghai (*b*).....	8,556,508	8,816,454	17,372,962
Rotterdam (*a*).....	7,868,819	7,696,416	15,565,235
Liverpool	8,145,441	7,125,417	15,270,858
Constantinople	.....	.....	15,108,000
Montevideo (*b*)	6,806,000	6,700,000	13,506,000
Cardiff	5,295,331	8,193,312	13,488,643
Marseilles (*a*).....	6,410,384	6,578,082	12,988,466
Singapore (*a*, *b*, *)..	6,362,458	6,401,916	12,764,374
Kobe	5,432,880	5,305,123	10,738,003
Colombo (*a*)	5,179,045	5,139,749	10,318,794
Newcastle	4,334,783	5,635,064	9,969,847
Genoa (*a*)	5,132,159	4,797,722	9,929,881
Moji (Japan)	4,507,377	4,419,933	8,927,310
Gibraltar (*a*)	4,018,495	4,108,021	8,126,516

There are many other ports of considerable prominence for one reason or another, which fall below 8,000,000 tons for total figures. These include Dover, 5,160,156; Glasgow, 4,798,826; Southampton, 4,219,305; Boston (*d*), 5,263,002; Philadelphia (*d*), 4,665,059; San Francisco (*d*), 1,734,429; Havre (*a*), 6,578,103; St. Petersburg (*a*), 3,131,398; Copenhagen (*a*), 5,396,332; Naples (*a*),7,428,891; Malta (*a*), 7,436,517; Alexandria, 6,347,029; Aden (*e*, *), 5,957,722; Bombay (*e*), 3,128,394; Calcutta (*e*), 3,279,683; Cape Town (*c*), 6,874,682; Yokohama, 6,517,922; Nagasaki, 5,385,248; Valparaiso (*a*), 1,947,000; Buenos Aires (*c*), 7,470,437; Rio de Janeiro (*a*, *b*), 6,205,015; and Havana (*a*), 4,497,665.

It will be noticed that a number of ports have changed places in order of size. New York, which was second in the first list, has now become first by a large margin, while Hong Kong, Antwerp, London and Hamburg, following in the order named, are having a close fight for pre-eminence in this respect. It should, of course, be noted that the figures are not all of the same date, and that in consequence some allowance must be made. For instance, the figures for New York are latest of all, and hence should be discontinued to a certain extent to put them on a par with the others. The great growth indicated for this port, however, amounting to not less than 2,913,566 tons in two years, represents the very large increase of 15.4 percent during this period. This is a higher figure than the rates of increase of any of the others among the four or five leaders, and would seem to indicate that this, the only port in the United States which has a foreign-going tonnage movement of more than 6,000,000 tons per annum, has become the premier port of the world, and, unless all signs fail, will continue to hold this position for some time to come.

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* Excluding junks and other native craft.

a, 1905; *b*, all tonnage, foreign and coasting; *c*, 1904; *d*, year ended June 30, 1907; *e*, year ended March 31, 1906.

THE HEATING AND VENTILATING OF SHIPS.

BY SYDNEY F. WALKER, M. I. E. E.

Both heating and ventilating have only within recent years received serious consideration, either ashore or afloat. On shore heating has been confined, in the United Kingdom, almost universally to open coal fires, and ventilation to opening windows and doors. In America and Canada, heating on shore has been more seriously studied for some considerable time, because of the more severe conditions of climate at certain times of the year. With the comparatively mild winters of the United Kingdom, a well warmed room in cold weather has been sufficient for most individuals. In parts of America, and practically the whole of Canada, the severe winters have obliged householders to provide means of heating, not only living rooms, but passages, halls, etc., and this has led gradually to the development of the improved forms of heating and ventilation that are now common on both sides of the Atlantic.

The same remarks apply practically to heating and ventilating on board ship. In the great majority of cases until recently, and in a very large number of ships, particularly in

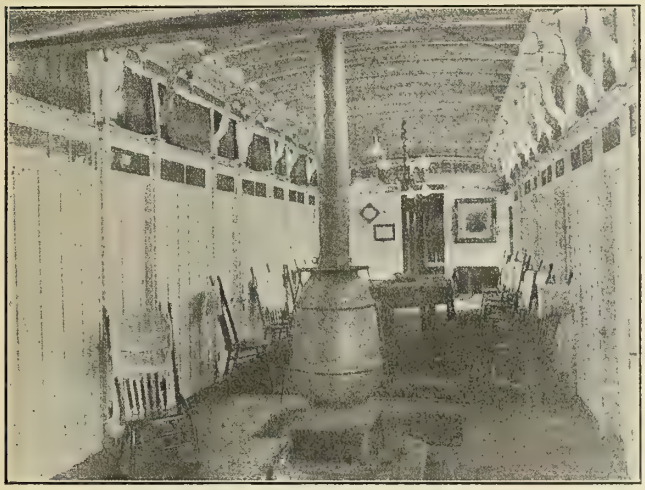


FIG. 1.—CABIN OF AN OHIO RIVER TOWBOAT, SHOWING THE OLD FORM OF CLOSED HEATING STOVE AND PIPE.

small craft, even now, just as in large numbers of private houses on shore in the United Kingdom, heating has been accomplished either by the familiar stove, standing in the middle of the mess room, with its chimney passing up through the deck above, as shown in Fig. 1, a cabin on an Ohio river tow boat, or in certain cases through the side of the ship. In the saloons of passenger steamers, and the mess rooms of the executive officers in the better class of tramp steamers, the iron stove has been displaced by the fireplace, built into a fireproof recess, similar to those employed on shore. Ventilation on board ship has been confined to opening ports and hatchways when the weather allowed, assisted by an occasional windsail, and by ventilators leading from the different messes, saloons, etc., to the upper deck.

The advance of modern science, and particularly the advance of medical science, has shown this method of ventilation, or absence of ventilation, to present very grave dangers to those on board who have to remain below; in emigrant ships, for instance, in which large bodies of men, women and children, often of all nationalities, often of not too cleanly habits, often again of not too robust health, have been confined between decks, with very little air from outside penetrating to them whenever the weather was sufficiently bad to oblige ports to be shut and hatchways to be closed.

Modern medical science teaches that in such cases diseases, sometimes unknown to their possessors, are rapidly propagated. It is now known that diseases are communicated by minute organisms variously known as bacilli and bacteria, and these breed rapidly under the conditions named. The same kind of thing rules on shore, where large numbers of men and women are confined in small spaces, badly ventilated, as in some of the workrooms, etc., that were common not long since in the east end of London. In addition, it is well known that consumptives are frequently sent to sea with the idea that the sea air will arrest the progress of the disease, and if there be any of these among the passengers confined between decks in bad weather, the results can only be the making of additional consumptive patients. Air is to bacilli, and to the various emanations from unhealthy subjects, what water is to dirt.

Water, we know, if properly applied, dissolves dirt and other noxious substances, and if allowed to do so, will carry them away. One reason why Englishmen and Americans are so generally healthy and so usually vigorous is because they are fond of water. Some of the other nations of the continent of Europe, as we know, and particularly some of those from whom large portions of the emigrants are drawn, are not so fond of water, and the consequence is they bring to the steerage quarters germs that, if allowed under the conditions named, will breed disease, even where it is not already present or incipient.

There are two methods of ventilating that may be applied both to buildings on shore and to ships afloat. One corresponds to the weekly thorough cleaning that the good housewife bestows upon every room in the house. As we are sometimes painfully aware, every object in the room is displaced, and every corner is subject to the vigorous cleaning process, under which disease germs cannot exist. Similarly to rooms on shore, the 'tween decks, cabins, etc., afloat may be cleansed by throwing them open to a vigorous current of air, when the weather allows, by opening all hatchways, all ports, and moving everything and seeing that the air current penetrates to every corner, just as the housewife's broom does in the cleansing process.

The other method, which is more rational, and which modern science has approved, is to direct a current of air from the place where it is to be obtained in its purest form into each living room, as far as possible into each corner of it, and to carry it away in a direction different from that at which it entered, carrying with it the disease germs, the emanations referred to, and the carbonic acid that has been formed by the breathing of the occupants of the quarters, and also in minute particles of dust that may be present. Certain conditions are necessary in connection with the ventilating air current, just described. It must be a very gentle current that cannot be felt, except under special conditions, such as when passing through the tropics. In temperate climates what is known as a draft must be avoided, and that is one reason why the ventilation of houses is somewhat difficult. By a draft is understood a current of air passing through a room or living place, such as a cabin or mess room, at such a velocity that the heat of the body is carried off more rapidly than the circulation of the blood, and the chemical action of the food, etc., supplies it, with the result that persons subjected to the draft catch cold.

The rationale of the process is as follows: Air, when passing over any object at a higher temperature than itself, abstracts heat from it, every cubic foot of air passing over (say) a human body abstracting a certain quantity of heat, in proportion to the difference of temperature between the air and the body, and in proportion to the velocity at which the air travels, up to a certain limit. In addition, as we know, the human body is constantly perspiring and there is always a minute film of moisture present on the skin. The quantity of moisture present, due to this cause, varies with the individual. Some persons perspire very freely, others hardly at all. Again,

everyone perspires more when the weather is warm than when it is cold, and again more under exertion than when at rest. In any case, the air current, passing over the body, converts the moisture present on the skin, and which penetrates through the clothes, etc., into vapor, and in doing so, extracts heat from the body. Water and other liquids, it will be remembered, can assume the form of vapor only by absorbing into themselves a certain definite quantity of heat. When the perspiration upon the body is transformed into vapor, nearly the whole of the heat required to enable it to become vapor is taken from the body itself. This is the reason why perspiration is so good in hot climates, and why doctors, and those who are accustomed to the tropics, are so insistent upon the production of perspiration. In the tropics one frequently hears "old stagers" say they feel all right as long as they can perspire. The evaporation of the vapor cools the body, and a gentle current of air, passing over the body, accomplishes this.

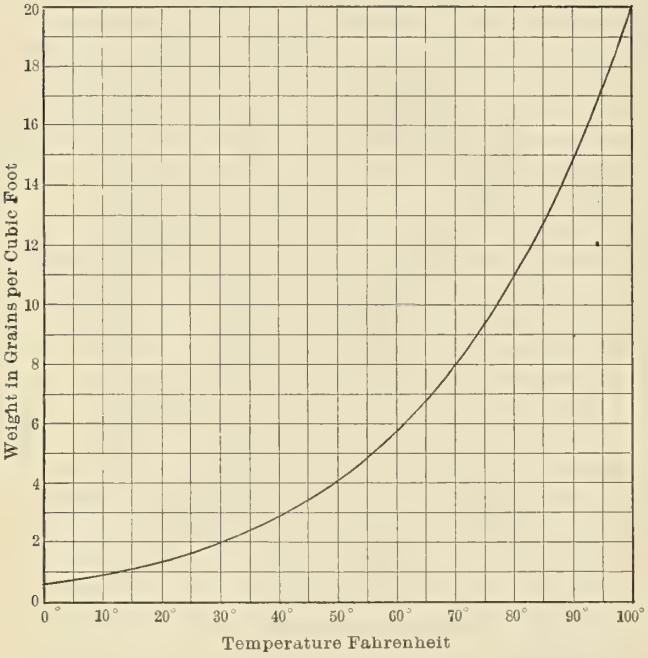


FIG. 2.—CAPACITY OF AIR FOR VAPOR, AT VARIOUS TEMPERATURES.

In temperate climates, however, and in cold climates, where it is required to keep the heat in the body, a draft of air passing over it tends to cool unduly the particular part over which it passes, and to produce the unpleasant feelings we know as catching cold. Consequently, one of the first requirements is that the velocity of the air in temperate climates should be such as not to be felt. In the institutions on shore, for instance, which have adopted mechanical systems of ventilation, it is impossible to tell, without making special tests for the purpose, that any air current is passing.

SPECIAL REQUIREMENTS ON BOARD SHIP.

The requirements of ventilation and heating on board ship are different in a great many cases from those on shore. On shore, even in countries where there are large variations of temperature, as in the United States, Canada, Russia, etc., different temperatures are confined to certain parts of the year. Thus, during certain months of the winter, a very low temperature rules, while during certain other months of the summer a high temperature may rule. In such countries as the United Kingdom, the variation of temperature is usually very gradual, indeed. On the other hand, a ship trading (say) between Liverpool or New York and the Cape of Good Hope, or between Liverpool or New York and San Francisco, will experience wide differences of temperature in very short periods of time. Thus, supposing the ship leaves either Liverpool, New York or Boston in the depth of winter, for San Francisco, the temperature will at first be very low; it will gradually increase until in the tropics it will be very high. It will again decrease, and in the neighborhood of Cape Horn may be very low again, gradually increasing once more as she makes her "northing," and so on.

Further, there is a very important matter that has to be considered in connection with the ventilation of ships which pass through the tropics, and of others which go to other climates, viz., that of the humidity of the atmosphere. Humidity, as we know, varies considerably, and the variation has a very important bearing upon the effect of a current of air upon the human body. It was mentioned above that in the tropics, for instance, if one is perspiring, a gentle current of air has a cooling effect, by evaporating the perspiration, but this is only on condition that the atmosphere itself is not already saturated with moisture, as it is at certain times of the year, and as it may be quite easily between decks at almost any time. The capacity of the atmosphere for moisture varies with its temperature, according to the curve shown in Fig. 2. It will be noticed that the capacity for moisture goes up very rapidly after a temperature of 40° F. is reached. Thus, at 40° F. its capacity is 3 grains per cubic foot; at 60° F., 6 grains; at 80° F., 11 grains, and at 100° F., 20 grains. Dry air, therefore, at a high temperature has a larger capacity for moisture than dry air at a lower temperature.

But the ability of the atmosphere to evaporate moisture from any substance, or body of liquid, depends very largely upon its own condition of saturation. Thus, if it is already fully saturated with moisture, no evaporation will take place from the body over which it passes, and under certain conditions, deposit of moisture may even take place from the atmosphere onto the body. The question whether moisture shall be evaporated from any body, or be deposited from the atmosphere on the body, depends upon the tension of the vapor issuing from the body, as opposed to the tension of the vapor present in the atmosphere. The tension of the vapor in the atmosphere depends upon its degree of saturation, while the tension of the vapor issuing from the body depends upon its temperature.

Hence, when the atmosphere is in the condition we know as "muggy," that is to say, when it is saturated with moisture, as it is in the tropics just before the rainy season, and as it may easily be between decks, and particularly in the stoke hold under certain conditions, even with a ventilating current passing, the cooling effect that should be obtained is not present. On the other hand, with a warm, dry air, used as a ventilating current, and having a large capacity for moisture, as explained above, the evaporation from the body, even with a comparatively gentle air current, may be so great as to produce a serious cooling effect, though the air itself is comparatively warm. Hence, where a ventilating air current is employed, in temperate or cold climates, it may be necessary to add moisture to the air current, in order that the cooling effect, owing to the possible evaporation from the body, may be reduced. It will be understood that while in a hot climate, warm, dried air passing over warm bodies produces a delicious cooling effect; in temperate or cold climates, during the cold season, the same warm dry air may produce an undue cooling effect, a cooling effect that is undesirable, for the same reason, owing to the evaporation of the perspiration. Hence it is necessary in some cases to add moisture to the air current. It is an axiom among heating and ventilating engineers that a moist air current of comparatively low temperature is "warmer" than a dry air current of a higher temperature.

DIFFICULTIES PECULIAR TO SHIP WORK.

One of the difficulties in connection with both heating and ventilating on board ship is the fact that in bad weather the

ship "knocks about." There may be said to be two distinct problems before the heating and ventilating engineer in ship board work, viz., that presented by the ordinary ship, which behaves like a cork when there is a sea on, and that presented by the modern ship, which keeps a practically even keel. Modern naval architects who have designed warships, and those who have designed ocean liners, have both striven after the same thing, a steady platform under all conditions, but for totally different reasons.

A steady platform is required by the modern warship in order that the guns may be properly fought. In the battle of the Sea of Japan, it is stated that the Russian gunners were very much handicapped by the fact that their ships, being very heavily loaded with coal, and not being designed to keep an even keel, rolled very much in the heavy sea that was on, while the gunners were not practiced in firing with the ship rolling. Even the most practiced gunlayer cannot do so well with a ship rolling as with a ship steady, and hence every effort has been made, and with apparently considerable success, to provide a steady platform. The naval architects who have designed the ocean liners have striven after the same results, and with apparently almost equal success, in order to neutralize the effects of *mal-de-mer*. With the increased ocean traffic, particularly between the United Kingdom and America, the ship which can carry its passengers, even through a gale of wind, with little danger of sea sickness, commands the largest share of the traffic.

Evidently, ventilating and heating problems are very much simpler in these ships than in those which knock about, and the more a ship knocks about, the more difficult are the two problems. One hears tales of ocean tramps, generally of the older type, rolling so badly, if there has been any sea on, that the galley fire could not be lighted, say between Bilbao and Cardiff, and so on. The additional difficulties presented by a rolling ship in the problem of ventilation and heating will be dealt with later on, but meanwhile it will easily be understood by anyone who has sailed in a ship which rolls very much that everything is very much strained. In old wooden ships it was quite common to see the ship's side bend inwards, as that side rolled downwards, the resilience of the timbers assisting to bring her up again. The iron shells of modern ships have not the resilience of the old wooden ships, but they must give to a certain extent, and every roll and every pitch strains every bolt, duct, etc., and produces eddies in water, air, and so on, that are used for heating and ventilating.

Another difference that arises between ventilating on shore and ventilating on board ship is the air current created by the passage of the ship through the water. On shore the wind has to be taken into account in designing systems of ventilation for buildings, and the wind must also be taken into account in connection with ship ventilation, and in some cases with heating, but the passage of the ship through the water is constant, and by itself it creates a powerful ventilating current. For instance, the maximum velocity of air in the ordinary ventilating air current on shore is 5 feet per second, and many ventilating engineers prefer even the lower velocity of 3 feet. The tramp steamer, running at from eight to ten knots, produces an air current of from 13 feet to 17 feet per second; at 16 knots, which is a very common speed at the present day, the velocity of the air will be 27 feet per second; while that of the *Lusitania* is somewhere in the neighborhood of 40 feet per second.

In hot climates, the air current produced by the passage of the ship will be very useful, indeed, in cooling the air between decks, etc., but in cold climates, and in particular in those regions in which whaling ships, sealers, etc., have to cruise, the air current is a very serious matter, and must be warmed, as will be explained, and possibly humidified, before being allowed to penetrate between decks.

Ventilation of ships has one important advantage over ventilation on shore in some cases, notably in some of the large and smoky towns, inasmuch as there is no difficulty whatever in obtaining absolutely pure air, rich in ozone, the most powerful oxidizing agent available, and there is a complete absence of any necessity for cleansing the air. On shore, in large towns, one of the most important matters in connection with the ventilation of public buildings consists in the purification of the air. Various devices are employed, and in all of them the quantity of dirt,—of black coaly matter such as steamers too often have distributed over their decks when burning bad coal,—that is deposited in the receptacle provided for it, is astonishing.

(To be continued.)

THE CUNARD STEAMSHIP MAURETANIA.

Our description in October of the *Lusitania* will apply almost equally well to her sister ship. The difference between the two ships from a fundamental point of view is slight, but a number of minor differences, and particularly differences in the decorations, have been made. The present ship was built by Swan, Hunter & Wigham Richardson, Limited, Newcastle-on-Tyne, and has been supplied with propelling machinery by the Wallsend Slipway & Engineering Company, Limited. The general dimensions are as follows:

Length over all	790 feet
Length between perpendiculars	760 feet
Breadth, molded	88 feet
Depth, molded	60 feet 6 inches
Gross tonnage	33,200
Mean load draft	33 feet 6 inches
Corresponding displacement in tons	38,000
Designed horsepower	68,000
Contract speed (one round trip per year)	24.5 knots

It is thus seen that the vessel exceeds the *Lusitania* in depth by 1½ inches, and in gross tonnage by 700. Provision is made for 2,165 passengers and a crew of 938, making a total of 3,103. Of the passengers, 563 first class are carried in 253 staterooms, 35 of which are each for one passenger only; 464 second class passengers are carried in 133 staterooms; while the third class, 1,138 in number, are carried in 278 rooms with from two to eight berths each. The seating accommodation of the various dining saloons are 470 in the first class, 251 in the second class and 520 in the third class.

While externally and internally the *Lusitania* and the *Mauretania* are similar in the main features of their design and arrangement, there are differences in detail that are readily apparent. What most strikes one on approaching the *Mauretania* is the difference in the overhead deck erections. Where the *Lusitania* has square trunks with hinged covers for the ventilation of the stokeholds, the newer ship has wide-mouthed ordinary cowls, and as they are a good deal higher, they somewhat enhance the appearance of the vessel. Then, again, the promenade deck and also the boat deck above project over the shelter deck by about two feet for nearly three-fourths of the length of the vessel. This, on the two decks on which this arrangement has been carried out, makes a very appreciable addition to the free space for promenading on both sides of the ship.

Internally, while the arrangement of the various apartments is almost identical in the two vessels, there is an entire contrast in the architectural treatment and decoration.

Speaking broadly, the prevailing aspect of the public rooms in the *Lusitania* is one of lightness and brightness, the outcome of a liberal use of light-colored enamels and gilt. In the *Mauretania*, on the other hand, costly woods in their natural colors are relied upon for decorative effect, producing what might be described as an impression of handsomeness and substantiality. Both schemes of decoration are successful in their own way, and preference for the one or the other will differ according to the taste or temperament of the individual. The dining saloon and upper saloon in the *Mauretania* are in oak in the Francis I. style, beautifully carved. In the main entrance hall and staircase the design is Italian renaissance, carried out in French walnut, and the same style in the same wood, with the addition of satinwood inlay, is used with fine effect in the smoking room. The library is done in sycamore of a beautiful grey shade, and is furnished in Louis XVI. style, and the same style is carried out in the lounge and music room in mahogany, with large tapestry panels flanked by duplicate pillars of grained marble. The staterooms and regal suites of rooms are variously treated in Adams, Georgian and Sheraton styles.

Equal taste, and not much less expenditure, have been bestowed on the second class accommodation, in which the dining saloon is in oak after the Georgian period, the drawing room in maple, in a modified Louis XVI. style, the smoking room in mahogany, and the lounge and entrance hall in polished teak. A new feature in the second class accommodation is a large deck shelter, which must add greatly to the comfort of the passengers in cold or stormy weather. In their degree, the third class passengers have also been liberally dealt with, both in their dining saloon and sleeping quarters, the latter being exceptionally large and airy, while the former is nicely finished in polished ash.

THE WRITING ROOM.

THE SMOKING ROOM.

THE MACHINERY.

The ship is propelled by steam turbines of the Parsons type, some of the illustrations of which, before being fitted to the vessel, will be found in our issue of November, 1906. The total heating surface of the twenty-five boilers (twenty-three double-ended and two single-ended cylindrical) is 159,000 square feet (3.65 acres); the grate surface is 4,060 square feet, and the boilers are fitted for Howden's forced draft. The boilers have shells of high tensile steel, and discharge the products of combustion into four elliptical funnels with outer

casings measuring 26 feet fore and aft and 19 feet athwartships. The 192 furnaces are of the Morison suspension type, built by the Leeds Forge Company. Each furnace has a separate combustion chamber.

The turbine rotor wheels, which are usually two in number, one at each end of the drum, are supplemented in this case by two inner wheels to stiffen the drum in its great length. The line shafting has a diameter of 22 inches, but in the bearings from 2½ to 12 inches in length. The low-pressure drums are 140 inches in diameter and 48 feet 2 inches long, with eight stages of blades, varying from 8 to 22 inches in length. The astern turbine drums are 104 inches in diameter and 30 feet 1 inch long, with blades from 2 to 8 inches, in eight stages.

In the rotors and lower half casings the usual method of fitting blades has been followed. This consists in first fitting

THE MAURETANIA AT FULL SPEED AT SEA, SHOWING THE ARRANGEMENT OF VENTILATORS AND FUNNELS.

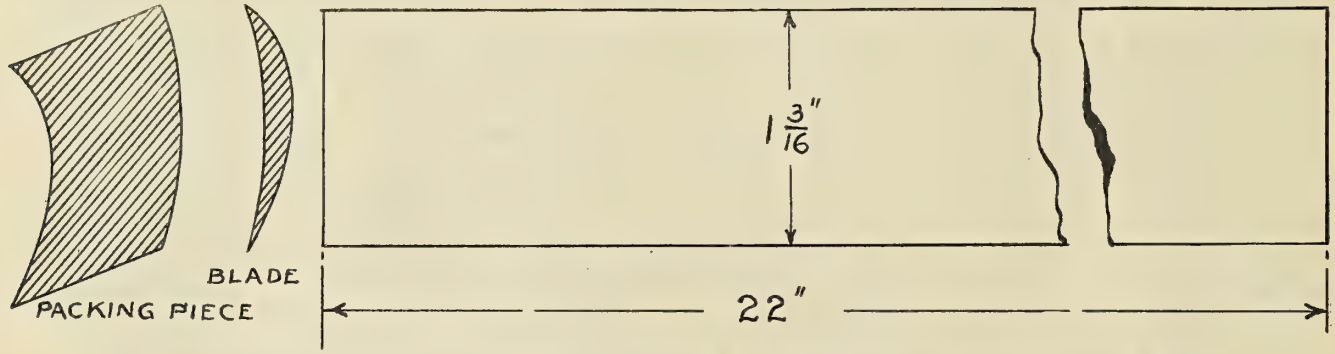
it is increased to 36 and 52 inches, a conical section being interposed. The bearings are about 5 feet in length. The propellers have a pitch of about 16 feet, and operate at a slip of about 15 percent.

The disks and gudgeons, as well as the shafts and drums of the turbines, were made of Whitworth fluid pressed steel, all stiffeners being solid and integral with the drums, with the idea of getting maximum strength and rigidity with minimum weight, and also to avoid distortion or straining in heating up or cooling down. The high-pressure drums are 96 inches in diameter, and the rotors, including bearings, are 45 feet 8 inches long. The blades, in eight stages, vary

a fixed stop piece, which sets the correct blade angle. This is held in position in the rotor groove by means of a steel wedge. The first blade and packing piece are then inserted, and, after a number are in position, the set is tapped up with a hammer and tool and afterwards calked. The blades are held together and stiffened by wire binding, the brass wire being fitted into a small saw cut near the upper end of each blade, and passing on to the successive blades in turn. This forms a brass ring extending around the circle of blades near their upper end. In longer blades two such rings are employed, and in the 22-inch blades of the low-pressure turbines are three sets of wires. A fine copper wire is lashed

around each blade and its brass binding wire, to hold everything solidly in place, and the entire connection brazed over by means of silver solder.

The turbine blading in the upper half of the casings is on the Willans & Robinson system. "The blade roots are fitted into two solid half rings, which are accurately divided off by machine cuts, and thus give uniform adjustment to the blade pitches and angles throughout. At the outer ends or tips the blades fit, by means of a tang, into a channel-shaped brass ring or shroud. The blading is completed independently in two or more sections before being fitted into the casing. The channel-shaped shroud can be adjusted to reduce the tip clearance and, should fouling occur, the channel ring would wear away and give its own clearance, or would perhaps bend over, thus protecting the blades and eliminating the danger of blade stripping. It will be noted that in this system no separate packing pieces are required, and that the brass wire binding and upper wire lacing are required only in the case of the very long blades near the low-pressure end of the low-pressure turbines."*



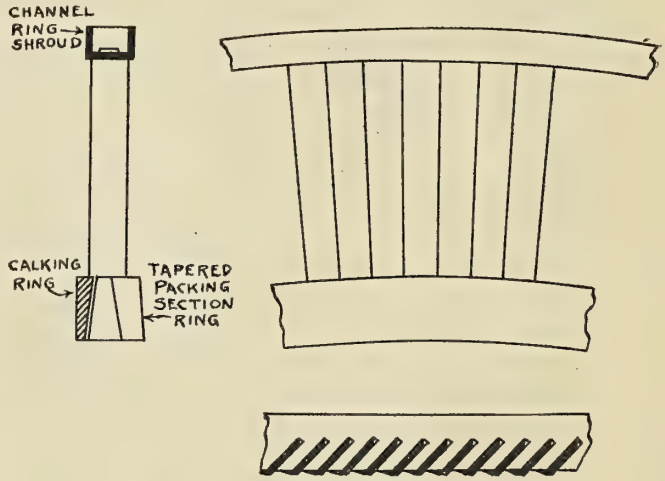
A FULL-SIZED DETAIL OF ONE OF THE LOW-PRESSURE BLADES IN THE MAURETANIA, WITH SECTION OF PACKING PIECE.*

The numerous pumps and other steam auxiliaries include a large number by G. & J. Weir, Limited, Cathgart, Glasgow. Others are by W. H. Allen, Son & Company, Limited, Bedford; J. H. Carruthers & Company, Limited, Glasgow; Clarke, Chapman & Company, Limited, Gateshead-on-Tyne, and Brown Brothers, Newcastle. In addition, there are pumps by the Liverpool Engineering Company in connection with the refrigerating plant, and pumps by J. Stone & Company, Deptford, London, for the Stone-Lloyd system of watertight bulkhead doors. Heating and ventilating is on the thermo tank system, by the Thermo Tank Ventilating Company, of Glasgow. Electric lighting is provided by four turbo-generators, each of 375 kilowatts, supplied by C. A. Parsons & Company, Limited, Heaton-on-Tyne.

The stern frame and bracket casting for the two inner propellers is a mammoth piece of work by the Darlington Forge Company, Limited, the weight being 104 tons. The strut frames for the outer propellers weigh together 48 tons, while the rudder, with an area of 420 square feet, weighs 63½ tons. The stem bar and stem foot piece are respectively an ingot steel forging weighing 8½ tons, and a cast steel member of 1½ tons.

There are twelve transverse bulkheads, and intermediate wing bulkheads are fitted in the side bunkers, dividing them into spaces about 40 feet long. Including the double bottom, there are altogether 175 watertight compartments. For a distance of nearly 350 feet alongside the boilers, the ship has a complete inner and outer skin, not only on the bottom, but also on the sides, being in this respect similar to warship construction.

The maiden trip (Nov. 16 to 22) of this ship was unfortunate by reason of tremendous seas due to a heavy gale. A spare anchor was torn loose, and it is estimated that the total loss in time occasioned by this and the storm aggregated seventeen hours. As it was, however, the distance of 2,780 nautical miles between Daunt's Rock and Sandy Hook lightship was covered in 5 days 5 hours and 10 minutes, at an average of 22.21 knots. On one single day, however, the ship covered 624 nautical miles, which makes the day's run at the rate of 24.99 knots. This is six miles more than was covered by the *Lusitania* in her highest day's run, a few weeks previous, and makes a new record. During this run the *Mauretania's* revolutions averaged 172 per minute, and did not exceed 180. On her trial trip, however, the revolutions reached as much as 194 per minute, the average speed for more than 1,200 miles having been a little more than twenty-six knots. During a portion of this time the speed was 26.75 knots, and one run of 300 miles is stated to have shown no less than 27.36 knots, by far the highest speed ever shown by any vessel over 300 feet in length.



WILLANS & ROBINSON BLADING OF STEAM TURBINES.

Of 307 steamers arriving at the port of New York from other lands during the month of November, only 37 were American. No less than 114 flew the British flag, 58 were German, 28 were Norwegian, 15 were French, 11 were Italian, and 10 were Dutch. Coastwise traffic accounted for an additional 208 steamers, all being American, and for 341 sailing vessels, of which 6 were barks and 335 schooners. The sailing vessels from foreign lands numbered only 69, of which 56 were schooners (38 British and 18 American). The total arrivals at the port numbered 925, or an average of 31 per day; of this number, 515, or 17 per day, were steamers, and 410, or 14 per day, were propelled by sails. The large use of sails in coastwise work is shown by the fact that 62 percent of the arrivals were sailing vessels, as compared with only 18 percent in the foreign trade.

* J. W. Sothern: *The Marine Steam Turbine.*

FIFTEENTH ANNUAL MEETING OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

This convention took place in the Engineering Societies Building in New York on Thursday and Friday, Nov. 21 and 22, 1907. The first session was called to order by the president, Rear Admiral Francis T. Bowles, president of the Fore River Shipbuilding Company. The secretary-treasurer, in his report on the condition of the society at the close of the fiscal year, Oct. 31, 1907, showed a total membership of 801, as compared with 857 at the end of the previous year. By the admission of twenty-seven new members the present figure becomes 828. From the financial point of view, the society is in a flourishing condition, receipts during the year having aggregated $10,912 (£2,242). The total disbursements amounted to $10,663 (£2,191); included in these disbursements the sum of $5,505 (£1,131) accounted for the publication of Volume XIV of the *Proceedings*. The present resources of the society, after writing off doubtful accounts, aggregates $26,694 (£5,485) with no liabilities against it. This shows an increase during the year of $1,799 (£370).

The following elections of new members took place:

Members (15).—Carlton B. Allen, New Rochelle, N. Y.; Ernest H. B. Anderson, New York; J. I. Chaffee, New York; Ole G. Halvorsen, Camden, N. J.; Peter Cooper Hewitt, New York; Robert Hunter Laverie, Mariner Harbor, N. Y.; George M. Magruder, San Francisco, Cal.; Lewis B. McBride, Navy Yard, New York; Yoshihiko Mizutani, Kure, Japan; Charles A. Parsons, Wallsend-on-Tyne; Robert S. Riley, Providence, R. I.; James M. Smith, Collingwood, Canada; Robert J. Walker, Wallsend-on-Tyne; Axel Welin, London; Louis Williams, Superior, Wis.

Promotion to Member (6).—Harold Lee, Seattle, Wash.; Harold W. Patterson, New York; James G. Purdy, New York; John A. Spilman, Bath, Me.; Henry R. Sutphen, Bayonne, N. J.; Allen D. Woods, Jersey City, N. J.

Associates (4).—Bentley Gardiner, New York; Holden C. Richardson, Newport News, Va.; Clayton M. Simmers, Puget Sound, Wash.; Henry A. Wise Wood, New York.

Juniors (8).—Frank E. Bagger, Brooklyn, N. Y.; John C. Burkhard, Ithaca, N. Y.; Constantine D. Callahan, San Pedro, Cal.; Fayette A. Cook, Ithaca, N. Y.; Wayne T. Dimm, Newport News, Va.; Dayton E. Herrick, Newburg, N. Y.; Harry A. F. Lynx, New York; Fritz A. Postel, Ithaca, N. Y.

In connection with the death during the year of Mr. Charles H. Haswell, one of the two honorary members of the society, the president appointed a committee, consisting of Messrs. Stevenson Taylor, Lewis Nixon, W. M. McFarland, Col. E. A. Stevens and Captain W. J. Baxter, to draw up suitable memorial resolutions. The other honorary member, Sir William White, K. C. B., was represented by a letter to the society, in which he regretted his inability to be present. The exercises terminated in the annual banquet at Delmonico's, on the evening of Nov. 22.

PAPERS READ THURSDAY MORNING.

No 1.—An Experimental Investigation of Stream Lines Around Ships' Models.

BY D. W. TAYLOR, NAVAL CONSTRUCTOR, U. S. N.

(This paper will be found at page 20.)

DISCUSSION.

William Hovgaard.—In connection with the stream lines it would seem that the location of the bilge keel might be largely dependent upon the flow of water around the sides and bottom of the vessel. In a torpedo boat some years ago we had difficulty in placing these keels, because of the greatly increased resistance. They were placed on a diagonal of the ship, and were located first amidships and then pretty well forward. In the latter position, it was found that they decreased the speed of the ship from 22.5 to 21 knots. It would appear from the present paper that they must have been across the line of flow of water.

H. C. Sadler.—It is interesting to note the rapidity with which a particle from near the surface of the water reaches the bottom of the ship, this being in the case of the cruisers at from 25 to 30 percent of the length, and in the slower and fuller vessels at 12 to 18 percent. Astern, in the shallow types of vessel, the flow is seen to be nearly horizontal, while the deeper types have here a diagonal flow.

A. A. Packard.—It would be interesting to know how the increased length of stream lines increases the resistance and the theoretical coefficient of friction. The efficiency of the propeller must also be affected by the direction of these lines, because the water is not flowing to the propeller in the direction of propulsion. In small fast boats it seems now to be the practice to fit a center keel instead of bilge keels. This makes very slight addition to the resistance, and is quite effective in overcoming rolling.

Frank B. King.—In connecting with the bilge keels, it would be interesting to know something about the direction of flow of water particles at a distance of two or three feet from the side of the ship.

D. W. Taylor.—It will be noted that the water flowing along the bilge of the ship is not in contact with any part of the ship near the bow. All the bow particles seem to seek the bottom of the vessel, and that touching the bilges comes from outside. Experience in the navy has shown that the resistance of a bilge keel is about equal to that theoretically due to its wetted surface, or even in some instances less. These bilge keels are in a plane which intersects the central vertical plane of the ship somewhere above the load water plane. As to the determination of the stream lines at some little distance from the ship, this was tested at the stern by means of a silk mesh coated with sesqui-chloride of iron, the result showing that the lines formed around the hull were carried some little distance out in about the same form.

Regarding the efficiency of the propeller in stream lines making such an angle with the direction of motion, it may be said that a slip angle of 10 degrees is quite unusual in the propeller itself, and that as a result inclinations of lines of 15 degrees would give a negative slip for some part of the revolution, and a very excessive slip for the rest. In such a case a horizontal shaft would give virtual inclination between the propeller axis and the lines of flow, due to the fact that the water is rising aft.

No. 2.—Some Experiments on the Effect of Longitudinal Distribution of Displacement upon Resistance.

BY PROFESSOR HERBERT C. SADLER.

ABSTRACT.

The object of the investigation was to determine the effect of distribution of displacement only. With this end in view, the length, breadth, drafts, coefficients of form, and hence displacement, were kept constant throughout the series. A set of lines representing one of the existing transatlantic intermediate type was taken as a basis or mean form. In general, the two extreme forms represent: First, a vessel with 40 percent parallel middle body, and hence rather fine ends; and second, a vessel with no middle body and rather fuller ends; the midship section being the same for all types. It may be remarked that none of the forms is particularly extreme or beyond the pale of practicability.

Although it is not safe to draw general conclusions, the results of the above experiments for this particular form may

be summarized briefly as follows: With a given set of dimensions, length, breadth, draft and with a given displacement, it is advantageous, so far as the forebody is concerned, to use a comparatively long middle body and fine bow. In the after body, however, better results seem to be obtained by adopting a form with a more gradual diminution of area from the midship section aft. The action of the propeller should not be lost sight of in the design of the after body, but, in the series under discussion, it will be noticed that the form of the after body and shape of the waterlines give a fairly easy form, even in the case of the fullest shape.

DISCUSSION.

A. A. Packard.—The results of this paper show that we can readily vary the relation in fineness between bow and stern, with the dual result of providing easier propulsion and a cheaper form to build.

D. W. Taylor.—In the work at the model basin in Washington we first made elaborate preparations for recording the contours of waves upon the models tested. In all our experiments, however, we have found that we could draw very little information from the wave forms, and hence we have practically discarded the idea. The curve of resistance is all that we can use in analysis. For instance, in comparing the waves shown in this paper for various forms of bow and stern, it would seem that the wave for a fine bow and full stern, as well as for fine bow and fine stern, should give much higher resistance than that for full bow and full stern. As a matter of fact, however, the result is quite the reverse, and in some cases the resistance figures up for the full form, showing the least wave, more than double what it does for the others.

H. C. Sadler.—Our object in measuring waves was to make some comparison between the positions of crests and the wavy form of the resistance curve. With regard to the form of model, it was found that fining away the ends gave much better results than a longer and more gradual running out of the lines.

No. 3.—Further Tactical Considerations Involved in Warship Design.

BY COMMANDER A. P. NIBLACK, U. S. NAVY.

ABSTRACT.

To properly handle a fleet in the approach to the attack and in action there is certain information which it is important to easily and quickly ascertain, and certain orders or information which must be transmitted to the other ships or to other persons in each individual ship. These may be considered under three heads: (1) Interior communication; (2) Exterior communication (signaling); and (3) Tactics.

The proper point of view for the average line officer should be to make the most of the ships as they are. There is too little battle practice, *as if in battle*, to enable anyone to pronounce our present arrangements defective, except in minor details. Gunnery is the best test of ordnance. Battle tactics is the best test of the battle qualities of our fleet. There is to-day in our navy a tendency to formulate tactics rigidly on the basis of rectangular movements. At the risk of being heretical, after so many years of being very orthodox, the writer is inclined to believe that, in "sparring for position" in the approach to the attack, oblique movements have a possible use, rare it is true, but sufficient to justify a recognition of their not being altogether anathema.

DISCUSSION.

William Hovgaard.—It seems almost an axiom that no one of importance in a battleship engagement should be outside of the armor protection. In the battle of the Sea of Japan the flagship *Suvoroff* was put out of action almost entirely by shell fire. These shells were very sensitive and carried heavy charges. They were readily exploded by contact with even the slightest sort of resistance, and gave rise to a perfect hailstorm of splinters, besides the effects of blast and the generation of such heat as to set fire to anything inflammable in the vicinity. It seems to me that the conning tower of the future will have to be two stories high, with the ship controlled from one story and the guns from the other. It will be larger and much heavier than at present, and will have radial shields for minimizing danger from splinters.

Lewis Nixon.—The position of the officer in command will probably be directed by the exigencies of the moment. Nonmagnetic armor will have to be provided, in order that the compass may be placed within its protection.

The present boiler and line of piping under heavy pressure must go. The operation wears out the men and presents very serious problems, in addition to the danger. The use of crude oil as a fuel saves the men, but does not solve the other problems. We must do away with cumbersome uptakes and funnels, and with all necessity for such excessive ventilation as is now required to keep the temperatures below at a livable figure. The internal combustion engine, coupled in the case of larger vessels with the gas producer, is a splendid solution, and is one which is already at hand. The heat of the exhaust can be put to many uses, notable among which might be mentioned the distilling of sea water for the use of the crew. It is understood that steam turbines have not solved the problem of reducing weights, but that in many cases they are actually heavier than the engines they have displaced.

P. Hagstrom.—Battleship and cruiser turbines have turned out to be lighter than their corresponding reciprocating engines. With destroyers there is not much saving. When cruising turbines are fitted, there is required a considerably greater length than with reciprocating engines, but not so much height.

F. T. Bowles.—In spite of what is said against the turbine, it must be remarked as a matter of common knowledge that the turbine has done and is to-day doing what no other engine ever built has ever done.

A. P. Niblack.—Steering gear, as at present fitted to the American navy, is probably as good as any in the world. At the same time there are frequent cases where a ship has to drop out of station for repairs to the gear, lasting often not longer than ten minutes. The great disadvantage in the use of screws turning inboard is that they make the vessel steer badly. Range finders, as at present fitted, jar out of position under the shock of firing heavy guns. Even under such conditions, however, they remain good for attaining relative results; that is, for determining the relation between the range at one moment and that at some subsequent moment.

PAPERS READ THURSDAY AFTERNOON.

No. 4.—Submarines of Battleship Speed.

BY MASON S. CHACE.

ABSTRACT.

Existing types of submarines used in conjunction with mines tend to limit the rôle of the battleship in wars of the future to fighting on the high seas. If submarines are to fight battleships at sea and to threaten their existence, they must be of a type which possesses a surface speed at least equal to that of the battleship, combined with sufficient endurance to enable them to get within striking distance. Without such speed they will not be able to so place themselves as to utilize their ability to fight as submarines.

The military value of a fighting ship comprises many factors offensive and defensive, including speed and endurance. Different percentages of the total displacement are

assigned to each of these dependent factors in different classes of ships, variations in the distribution of the displacement differentiating one class of ship from another class. Within the limits of any one class these variations in weight distribution, from ship to ship, are comparatively small, but there still remain numberless possible combinations or compromises which can be made. The rule of compromise applies to large ships as well as to small ones, although often less apparently in the case of the former than in that of the latter.

When submarines of small displacement are proportioned for high surface speeds, they can attain these speeds and also have sufficient battery power to do effectual submerged work. They must of necessity be vessels of limited endurance. A harbor or coast-defense submarine can do much work in the way of catching an enemy if it has a surface speed of 12 to 15 knots, of which the vessel making only 10 knots is incapable. If high surface speeds, combined with great endurance, are desired for effective off-shore work, larger displacements are necessary. In such vessels it may be found advisable to fit triple screws, the central screw to be utilized for electric propulsion, and when cruising at an economical speed, driven by a small auxiliary engine; the auxiliary engine could also be used for charging the storage battery.

DISCUSSION.

William Hovgaard.—In a large boat it will be necessary to limit the depth of submergence of submarines on account of the prohibitive requirements for strength at great depths.

W. D. Taylor.—Battleships have no antidote against the submarine. All they can do is to run out of the way. The submarine is amply armored by the water in which she is immersed, and is practically immune from attack. In experiments on the resistance of submarines, certain models have shown critical speeds, on reaching which they would dive at once. This is supposed to have been the phenomenon which caused the loss of a French submarine some months ago. It should be noted, however, that these critical speeds are high, being about $1.3\sqrt{\text{length}}$. This is seen by the curves to be well beyond the final hollow in the resistance curve, and hence need not be apprehended for vessels of the usual design and construction.

M. S. Chace.—It has been suggested to give the elliptical section of the hull forward a vertical major axis, while that aft could have a horizontal major axis. This would be particularly applicable in case three screws were fitted. What the submarine needs in the way of speed is greatly increased speed on the surface of the water. The speed submerged is a matter of comparatively minor consideration, as is also the submerged radius of action. Surface speed, however, is absolutely required, in order that the submarine may get within striking distance of its enemy.

No. 5.—Motor Boats for Naval Service.

BY NAVAL CONSTRUCTOR L. S. ADAMS, U. S. N.

ABSTRACT.

Although this paper applies, primarly, to the introduction of motor boats into the naval service, and to gasoline engines of the lower powers, such as those in successful operation at the present time, a proposed gasoline (petrol) installation of much greater power will be of interest. The Standard Motor Construction Company has recently made a proposition to furnish a double-acting gasoline engine of 1,200 horsepower, consisting of two units of 600 horsepower each, coupled together, to be installed in the torpedo boat *Mackenzie*. This machinery will weigh about 10 tons less than the present steam equipment of 850 indicated horsepower, and there will be a further saving of about 6 tons in the weight of fuel. The present machinery weighs 29 tons, so that it is at once apparent what a proportionally large saving in weight will result from the substitution of the gasoline equipment. This fact alone makes the proposition worthy of the most serious consideration, not so much for any improvement that will result to the *Mackenzie*, as for the experience that will be gained from such an installation in connection with future designs, where the possibilities for improvement in the boat as a whole are greater.

On the other hand, it is believed to be an open question whether a gasoline installation of this magnitude can be made sufficiently safe. The danger of destruction of the boat from explosion or fire from an enemy's shell is great, and may be considered by some sufficient to render the installation inadvisable. In order to overcome this as far as practicable, the gasoline tanks should be located low in the boat, and protected by light armor, and the gasoline piping also should be carefully protected from possible damage from shell fire.

DISCUSSION.

R. C. Monteagle.—Gasoline is dangerous, in spite of claims to the contrary. It may be ignited in the mouth of a can, and a blue flame will be the result. If there is no air in the can there will be no explosion, but under certain densities of vapor and certain relations between air and vapor an explosion would be sure to occur. A great danger is that from leaky joints. About the only way to obviate this would be by the use of double copper tanks and double copper pipes, both fitted with a minimum of joints.

J. F. Craig.—There would be no objection to carrying gasoline on deck in steel tanks. It would, however, be out of the question in general to put it below, largely on account of the insurance risks. The gasoline engine, as usually built, is single-acting, and is a very hardy piece of mechanism, the only parts which are delicate being the carbureter and the igniter.

No. 6.—High-Speed Motor Boats for Pleasure Use.

BY HENRY R. SUTPHEN.

ABSTRACT.

Several manufacturers are now prepared to deliver from stock, or upon short notice, 18 and 25-mile motor boats equipped with gasoline (petrol) marine engines for pleasure use. The first fast boats produced were designed particularly for racing, and developed speeds of from 24 to 27 statute miles per hour, the hulls being of light construction and the engines of minimum weight. From the experience in building the racing launch, the high-speed pleasure boat has been developed, which fills the demand that has long existed for a safe, seaworthy boat that could cover distances over the water in the shortest possible time.

While the principal development of the high-speed launches has been in the open type of boat, attention has lately been given to the cabin launch, affording still further protection, comforts and carrying capacity, combined with high speed. In a 40-foot by 8-foot beam cabin launch of unique design, the motor is placed forward, protected with hinging hood; controlling levers and steering wheel being located in the engine cockpit. The boat is handled and the engine controlled by one man. An open space covered by the cabin roof adjoins the engine compartment, separated by a glass wind shield; with a commodious cabin amidships, inclosed by plate glass windows, with buffet and toilet compartments. The scantlings and details of construction are light, but found to be substantial. The boat is equipped with a 6-cylinder, 75-horsepower engine, with which power a speed of 18.85 statute miles an hour has been obtained.

The possibilities of further development of the high-speed motor boat for pleasure use are limited only in details of hull

and engine construction, the aim being to design and build boats that best conform to the high-speed gasoline marine engine, which has made possible this new type of power boat.

No. 7.—Some Observations on Motor-Propelled Vessels, and Notes on the Bermuda Race.

BY WILLIAM B. STEARNS.

ABSTRACT.

There are several details wherein the general treatment of the design of motor-propelled vessels must differ from that for steamers. The reason for this is that, except in vessels designed for weight carrying, or for craft of very high speed, the designer of the motor vessel is troubled to know how to get rid of the excessive buoyancy, quickness of motion and general liveliness which result from the lightness of the propelling machinery and fuel. On a given length a fairly liberal beam is usually necessary to provide the accommodations required by most owners. Sufficient displacement is obtained with a very shoal body, and unless the weights are distributed in such a way as to offset it, there is a strong probability that the vessel will be very uncomfortable on account of quick rolling. This can be reduced, to a certain extent, by keeping down the area of the load-water plane, and placing some of the weight fairly high.

In the Bermuda race we had practically no opportunity to try the boats against a head sea. Both during the race and on the return trip all the strong breezes experienced came from abaft the beam; but on several other occasions I have been in craft of this sort in comparatively rough water, and have found them astonishingly good sea boats. If anything, the tendency is to recover too quickly after plunging into a sea. This is due, of course, to the extremely high proportion of reserve buoyancy to displacement, and results in one fault—a tendency to pound. On account of this it is not always an objection to put a certain amount of weight near the ends, on the same principle that I advocate spreading weights transversely. Also, I believe that the lines both forward and aft, but especially forward, of a light displacement motor-driven vessel, should be kept considerably finer than would be found necessary on a steamer of the same size. A comparatively minor matter, to cite another point of difference, is the rudder. I believe a motor vessel will generally require a larger rudder than a steamer. We found on the *Idaho* that it was difficult to meet her with sufficient quickness to avoid considerable deviation from the course when running before a sea, even with a rather large rudder area for her size.

It does not require a prophet to foresee that in the very near future owners of motor yachts will rebel at the cost of gasoline (petrol). Even now its expense is prohibitive for commercial use in high powers, and the building of gasoline yachts has undoubtedly been restricted by its cost. As alternatives we have kerosene and producer gas, made either from coal or heavy oils. There seems to be no difficulty in the operation of certain types of motors by kerosene, but in some instances of which I have known there have been decided drawbacks to its use. At the same time the reduction in expense, although amounting to nearly 50 percent as compared with gasoline, does not bring the operating cost as low as that of a good steam plant for a moderate sized vessel. Of the use of crude oils and distillates we have not had much experience in this part of the country, but on the Pacific coast, vessels of 150 feet and over, which are driven by engines using crude oil, are not uncommon. On the whole, the use of producer gas from coal seems to promise the best results, both for yachts and commercial vessels, although when expense is not an object gasoline will continue to be used. This will undoubtedly be the case with a great many small launches, all speed launches, submarines and vessels such as torpedo craft, which may be driven by motors in the future. For yachts, the updraft producer with hard coal will probably be employed, but the type to be used is at present a matter which concerns the engineer rather than the architect. There seems to be no reason why gas producers, substantially like those in operation on land, cannot be used successfully on ships, and in combination with an efficient motor they offer very great advantages over steam plants. With a good producer a thermal efficiency of 87 percent can be reached, and I understand that it is perfectly safe to count on 75 percent under ordinary service conditions of operation. The fuel consumption can be figured safely as half that of steam.

DISCUSSION.

A. C. Smith.—The *BM* dimension of the *Idaho,* as originally fitted, was 7 feet; that of the *Ailsa Craig* only 3 feet. The *GM* of the *Idaho* was reduced by careful attention to the stowage of weights, the gasoline and other weights being stowed well forward and well aft. The weights in the *Craig* were largely amidships. The ideal type would seem to be some sort of a compromise between these two boats.

F. L. Du Bosque.—The producer, as applied on shipboard, requires considerable space and weight, and gives off dangerous gases—gases which are poisonous for respiration.

E. A. Stevens.—It would appear that the only way to displace gasoline is by the development of some cheaper or better fuel as a substitute.

PAPERS READ FRIDAY MORNING.

No. 8. Two New Revenue Cutters for Special Purposes.

BY C. A. M'ALLISTER, ENGINEER-IN-CHIEF, U. S. R. C. S.

ABSTRACT.

Those familiar with conditions existing on the Pacific coast, with especial reference to the Northwestern part of the United States proper, are aware of the extreme hazards of wind, currents and fog encountered by navigators in that locality. The entrance to Puget Sound through the Straits of Juan de Fuca is particularly dangerous, as throughout at least half the year fogs and haze prevail, and at all times erratic currents exist which are but little understood, even by men who navigate these waters constantly. Deep-water soundings may be obtained close inshore, so that not much dependence can be placed on the lead and line when vessels are headed in the straits. In the past half century nearly seven hundred lives have been lost in the immediate vicinity, to say nothing of millions in property. Numerous palliative schemes have been suggested, among them being international life-saving stations along the Vancouver coast. This, however, proved inadvisable, and, finally, after mature consideration, it was recommended that "a first-class ocean-going life-saving steamer or tug, officered and manned by the most skillful life-saving crew available, should be stationed at Neah Bay (which is within 5 miles of Cape Flattery and the entrance to the straits, and is the only available harbor in that vicinity), to be equipped with the best possible appliances of surf boats and lifeboats and with a wireless telegraph apparatus."

It is believed that the design of the life-saving vessel contemplates the furnishing of every known device of any practical value which can be of service in saving life at sea. Summarized, the special equipments of this vessel are as follows: Two self-bailing and self-righting lifeboats; life raft; line-throwing gun; breeches-buoy apparatus; complete equipment of life buoys and life preservers; wireless telegraphy; Ardois system for night signaling; additional searchlight; wrecking apparatus for pumping out vessels, and fire extinguishing apparatus.

Floating wrecks, or derelicts, as they are commonly termed, drifting aimlessly in the paths of ocean-going vessels, have been

a constant menace to searfaring men for years past. To the men on the bridge of a fast trans-Atlantic passenger steamer, the thought that at any moment they may crash into a half-submerged wreck and cause the loss of their vessel is anything but comforting. Other ships in their path at night are discernible by lights, or can be located by signals in fogs; even icebergs make their presence known by lowering temperatures, but the specter-like derelict gives no indications of its whereabouts. The danger of collision with these floating obstructions is known to all who travel by sea, yet until this time no systematic effort has ever been made to rid the ocean of these menaces to navigation.

The United States government, always foremost in any movement to promote the interests of humanity, has finally decided to be the pioneer in what is hoped will be an international system for removal of derelicts from the most frequented paths of ocean travel. To that end Congress recently passed a bill, appropriating $250,000 (£51,200), for the construction of a vessel to be used exclusively for derelict destroying.

DISCUSSION.

R. S. Riley.—The derelict destroyer ought to have towing machines if it is going to succeed in getting lumber-laden derelicts into a position where they can be broken up without danger of leaving floating wreckage in the paths of ships.

Spencer Miller.—A breeches buoy is a very good contrivance, and, although the passenger is almost certain to get very wet, and is sometimes brought ashore half drowned, or otherwise suffering from exposure, it is not on record that any life has ever yet been lost in this way, once the journey from the ship was started. In the United States alone, in 1906, no less than 189 passengers were carried ashore in this way. In the case of the *Berlin,* last February, it was attempted to rig up this device from a ship which proceeded outside the wreck. The sea was so high, however, that the lines snapped, and the device could not be operated at all. The present device for the life-saving vessel described consists of a common coast breeches buoy, with the addition of an automatic reel in the engine room. This reel will take in and pay out the rope as fast as the varying tension on the line calls for it.

No. 9.—Test on the Steamship Governor Cobb.

BY PROF. W. S. LELAND AND H. A. EVERETT.

(This paper will be found at page 21.)

DISCUSSION.

Andrew Fletcher.—The test was manifestly unfair, because apparently of inadequate and incomplete preparations. The curve of speed on revolutions per minute shows that the propeller lost efficiency just above 17 knots, which is at variance with the facts. In our tests of this ship she was run up to 19 knots without such loss of efficiency. On her run from New York to Boston with a green crew, she averaged for 14 hours 35 minutes a speed of 18.12 knots, and 459.3 revolutions per minute. In the present test the boiler pressure was only 128 pounds, in place of 150 pounds, designed, which must have had a marked effect on the economy. The figures again show an evaporation in the boiler of 10.65 pounds of water for each pound of coal. This must have been very remarkable coal.

D. W. Taylor.—The conditions must have been totally unsuited for speed, or else the log at high speeds was unreliable. The curve shows an increase of 2½ knots for an increase of 50 revolutions from 300 to 350, while the increase of 50 revolutions from 425 to 475 shows an increase of only ½ knot.

F. M. Wheeler.—It would appear that the extra vacuum used coal, and that the blower also used coal. These would have their effect upon the consumption per horsepower of the engines. Some years ago in the cruiser *New York* a test was made to determine the additional power required in the air pump for an addition of 1 inch to the vacuum, and at a figure like this the addition was very great.

No. 10.—Appliances for Manipulating Lifeboats on Sea-Going Vessels.

BY AXEL WELIN.

ABSTRACT.

The principal requirements of an ideal system of davits, such as they present themselves to me after several years of keen and careful study are: (1) The boat must, in all circumstances, and in every position, be under efficient control. (2) A moderate list of the ship must not prevent or appreciably retard the manipulation of the boat. (3) The mechanism should be of the simplest possible nature, and always "get-at-able." (4) The manner of manipulating the davits must be such as to preclude any necessity for expert training, and all possibility of confusion in cases of accident. (5) Cost, weight, and deck space occupied are all matters which must be taken into account, even if they do not come within the scope of the subject, when treated from a strict "life-saving" point of view.

Shipbuilders do not, as a rule, welcome deviations from orthodox designs; that deviations must ultimately come, I am nevertheless more than ever confident. At a time when scarcely a month passes without witnessing the birth of some new leviathan, each exceeding its forerunner in speed and passenger-bearing capacity, the compelling necessity for such vessels to be fully equipped with life-saving appliances of the highest order is a fact which cannot fail to thrust itself with an added force and conviction upon the observation of the most callous.

DISCUSSION.

Lewis Nixon.—When such improvements as the present come up for attention, they will be fitted whenever demanded by the owners. It is not usual, however, for the shipbuilder to go to this expense unless required.

Roland Allwork.—These davits simply put the boats over the side, but provide no special means for lowering them into the water. It would seem that this addition would make them much more valuable.

Frank E. Kirby.—This device has a large advantage over the usual davits in that it requires only one set of falls, that for lowering the boat. The usual device has an additional set for operating the davit. The proposition to store the boats on decks much nearer the water must commend itself to shipbuilders.

Axel Welin.—The pitch angle on the thread by which the davit is run out is just a little below the angle of repose. As a result, the boat will not run out by its own weight, unless it is operated by means of the crank. Lowering of the boat may be accomplished safely by means of brakes or winches, but in the present installations it has been desired to keep the mechanism as simple as possible. A winch, however, may be fitted if desired.

PAPERS READ FRIDAY AFTERNOON.

No. 11.—The Transportation of Refrigerated Meat to Panama.

BY ROLAND ALLWORK.

ABSTRACT.

This paper gives a description of what has been done in the way of transportation of refrigerated meats to Panama, for the use of the thousands of men located on the Isthmus and engaged in the construction of the Panama Canal. The fleet consisted of five steamers, only one of which was provided

with mechanical refrigeration. The system was the ammonia compression system, and, in the fitting out of three of the other four vessels, the same system was employed. The paper gives a very complete description of the installations fitted, and gives as well a log showing the operations of the plants.

Experience in both the fitting and the operation gave rise to recommendations of various sorts, it being found advisable, for instance, to use galvanized meat rails; to give a thin coat of graphite to whatever black pipe had to be used; and to line the refrigerating rooms with galvanized iron, it being found easier thus to keep them clean. The refrigerating machines fitted included one 5-ton plant and two of 7½ tons.

DISCUSSION.

Lewis Nixon.—The improvements and ingenuity shown in fitting up these vessels for their work have resulted in a paper, in which the author should be commended for the fine details and general completeness.

R. R. Row.—Cow hair may be recommended for insulation. This weighs about 13 pounds per cubic foot, and absolutely prevents all sweating, which would otherwise corrode the metal. It is more expensive than cork, but seems to do the work better.

No. 12.—Two Instances of Unusual Repairs to Vessels.

BY ASSISTANT NAVAL CONSTRUCTOR W. B. FERGUSON, JR.

ABSTRACT.

The collier *Nero* grounded about the 1st of August, 1906, off the Southeast Light, Block Island, and rolled back and forth a number of days on a stony bottom. The crew, movable stores, boats, etc., and about fifteen hundred tons of coal were taken ashore, and the wrecker had charge of the ship until she was finally floated and towed to New London, Conn., where the work was continued of removing coal and operating the wrecking pumps. On Aug. 20 the vessel was drawing 21 feet aft, and 18 feet 3 inches forward—her normal draft would have been about 11 feet aft and 9 feet forward.

An examination of the bottom after the vessel was docked showed the following conditions: The main keel was more or less bent and dented for its entire length; there were three large holes in the outer bottom plating, one at the turn of starboard bilge well forward, one at the turn of port bilge slightly forward of amidships, and one in the engine room through the port garboard strake. There were numerous smaller holes below turn of bilge. Many butts and seams had been started; many plates were bent and torn, and frames crushed in; numerous rivets were out or loose, and calking was generally started; the bilge keels were torn and portions hanging loose. There was buckling of floors and longitudinals in numerous places. The vessel was somewhat hogged, and bulkheads had leaked badly.

Temporary repairs were made by covering the worst holes and the indentations in their vicinity with spruce furring-off pieces, giving a smooth surface outside on which a temporary sheathing of 3 by 3-inch spruce was bolted. Elsewhere the leaks were stopped by calking and renewal of rivets.

The permanent repairs made provided for strength and watertightness, and while they did not put the vessel in her former condition, they were commensurate with the value of the remainder of the ship. Wherever the bottom plating required renewal, on account of large holes or torn plates, the frames, floor plates and longitudinals were also found to be in such poor condition that they had to be cut away and renewed. The small holes in the plating were patched locally. All sheared or loose rivets were replaced with larger rivets, after reaming the rivet holes. No reverse bars or inner bottom plating was renewed. Forward on the port side it was necessary to straighten the reverse bars in a few places. In a number of places dents were removed and frames straightened by heating them in place with annealing burners.

It was reported in April, 1907, from a preliminary examination of the planking of lightship No. 68, that several bolts in the underbody had been destroyed by galvanic action, which might be taken as an indication that serious deterioration of the fastenings of the vessel had taken place. Owing to the method of construction of the vessel, a good examination could not be made without removing the copper and wooden sheathing. The vessel was therefore docked in the New York navy yard for this purpose, and also in order to make necessary repairs; when the condition of the bottom was found to be much more serious than had been supposed, presenting an extraordinary case of the dangerous results of electrolysis and corrosion, resulting from using in the construction of the hull of a vessel metals which are electropositive and negative to each other.

In order to renew defective bolts, it was necessary to remove the water tanks, the cement covering the keel plates, and the coal bunker linings. Then the copper sheathing and oak sheathing were removed, and all the iron bolts and nuts securing the planking to the frames were replaced by naval brass bolts and nuts, the holes through frames being reamed out and ⅞-inch naval brass bolts—that is, ⅛ inch larger diameter than the original—fitted.

DISCUSSION.

F. L. Du Bosque.—A single sheathing of copper, fastened in the usual way, soon loses its value and the fastenings are wasted away. Muntz metal protects the bolts, but at once destroys the framing of the ship by corrosion. A suggested cure is the use of galvanized iron for sheathing in place of copper. It is not so durable, having to be replaced every sixteen or eighteen months, as in the case of zinc, while copper will last two or three years, when obtained of the grades now generally in the market. The cost, however, is less, notwithstanding the greater frequency of renewal, and the corrosive effects with regard to the hull are almost entirely eliminated.

J. A. Furer.—The use of composition sheathing in the case of a light vessel is not so much to prevent fouling of the bottom, which is unimportant with these vessels, but to protect the hull.

William McEntee.—The cruiser *New Orleans* is sheathed with teak on the outside of ⅜-inch steel plating. A composition casting for a sea valve has been run through the hull in a number of places, and is connected directly to the steel of the inner and outer bottom. In spite of the direct contact of the metals, however, no corrosion seems to have taken place.

W. J. Baxter.—The frames of the light vessel in question were not injured in any way. With the present method of fitting copper sheathing it is possible to watch for deterioration and to remedy it when it comes. With galvanized iron nothing can be seen, and a serious accident might result from a comparatively light blow on a part so badly corroded beneath the surface as to be spongy.

No. 13.—Wooden Sailing Ships.

BY B. B. CROWNINSHIELD.

ABSTRACT.

Although there were French and English scientists as early as the middle of the eighteenth century who made accurate calculations of displacement and stability, vessel models were but little affected by these studies, and, until the latter part of the last century, shipbuilding still continued to be an "art" and a "mystery." To-day, the steel vessels are minutely

figured, and accurate drawings are furnished for every part of the structure; each man does his allotted part, and the ship, as it were, is apparently built by draftsmen and boilermakers.

The men who turned out the wooden tonnage usually constructed the entire hull, frame, plank, ceiling, decks and joiner work. They were usually calkers, painters, spar makers, and riggers as well as carpenters; men of wonderful resource, self-reliant and skilful. They had been trained by long experience and by the traditions of their forefathers; and had learned by many failures and disasters what to avoid. Progress had been attained almost wholly by development. The model of each vessel was derived from, and was, in fact, the natural growth of, those immediately preceding it. Anything radically different was quite properly discouraged, there being no thorough workable knowledge of the natural laws of stability, flotation, or application of the law of the composition and resolution of forces, as applied to the problem of propulsion by sails.

It is unlikely that any more large wood square-riggers will be built for long voyages, a steel hull having many advantages. The hull can be subdivided by the bulkheads and a double bottom, so as to make a vessel practically unsinkable, and in case of fire it can be kept under better control than in a wooden ship. And, most important of all, the steel hull can be made absolutely strong and rigid and perfectly tight, the shell plating being practically continuous, and in a sense sufficient to hold the entire structure without the frames, and in marked contrast to the plank of the wood vessel, where each piece is attached only to the frames, which in turn are composed of comparatively short pieces.

The construction of wooden vessels has varied but slightly during historic times. White oak has always been used when it was procurable for keel, frames, ceiling, plank and beams, in fact, for the whole structure except the deck and deck erections, where pine has been almost always employed. Recently mahogany and teak have been imported from the tropics for all deck erections, and frequently entire decks are now made of this material. Oak has become scarce, and the price has increased enormously in the last one hundred years. This has led to the substitution of other woods for plank, beams and ceiling, and even for the frames. Georgia pine is now universally used for plank, ceiling, keelsons and beams in the large cargo vessels built in New England. In New Brunswick and Nova Scotia many successful schooners and even ships have been constructed entirely of spruce, but for the largest vessels as now built, spruce would not be suitable, because of the comparatively small size of the timber.

DISCUSSION.

A. J. Du Bois.—A number of fast sailing vessels designed by Steers might have been mentioned in the article, these including the famous *America;* the frigate *Niagara,* which laid the first ocean cable, and the sloop *Lancaster.* The latter was the most beautiful design ever included in the United States navy, and was known as the "naval yacht."

E. A. Stevens.—The yacht *Sappho* has a recorded speed of more than 16 knots for several hours. She lowered the sailing record between New York and Great Britain. It may be remarked in general, however, that a vessel built for extremely high speed for a short distance is usually the result of sacrificing qualities making for the highest average speed in a long voyage.

W. F. Palmer.—The interests with which I am connected maintain a fleet of fifteen or sixteen fore-and-aft sailing vessels in the coaling business. This year will be completed with a return of about 23 percent in dividends on the original cost of the fleet. We submit that no line of steamers in the world will show such a return. Sailing ships have been developed into their present form as the result of centuries of evolution, and present very little differences in general characteristics, where designed for the same sort of work. Steel and steam vessels even to-day are full of crudities, and are not nearly so well standardized or so adequately designed for their purpose as are the sailing vessels. Our ships are amply secured against deterioration and decay by the provision in many cases of three times the amount of timber really called for by necessities of strength.

Vessels which make fast runs are not necessarily dividend payers, and when it comes to a question of the vessel best suited for her purpose, that one which will pay the most dividends must be awarded the palm. At present, sailing vessels can compete on more than equal terms with steamers in the coastwise coaling trade. If the steam colliers could be assured of immediate service without delays, the sailing vessel could not compete with them, but the very high cost of upkeep of the steamers while waiting their turns to take on or discharge cargo entirely kills all chance of highly successful competition with the more economical vessel propelled by the winds.

F. L. Du Bosque.—It might be mentioned in this connection that more than nine-tenths of all the coal handled on the coasts is carried by steam-driven vessels. The sailing vessel has to wait for a wind, and sometimes for maneuvering into position where she can be taken care of at the docks.

F. T. Bowles.—The wooden schooner is considered by some to be a weight around the neck of New England. The methods employed in the transaction of business by means of these vessels are as antiquated as the Constitution.

No. 14.—Some Early History Regarding the Double-Turreted Monitors Miantonomoh and Class.

BY WILLIAM T. POWELL.

ABSTRACT.

Notwithstanding the absence to-day of advocates of the double-turreted monitor type of vessel, it may be of interest to recall some early history regarding the *Miantonomoh* and her three sister vessels. I investigated the range of stability, and the results given are the first complete curves, so fa as I know, in this country; nothing of this kind was in evidence when these vessels were being designed, though eagerly sought for at that time. There was not a planimeter available; therefore the work was tedious and long.

The first *Miantonomoh* and her three sister vessels were all built of white oak and yellow pine. In the course of years they became rotten and were broken up or sold. It was considered necessary as well as cheaper to rebuild them of iron rather than of wood, and in this connection it was the original intention to utilize the old side and deck armor, also the turrets and guns, and, in fact, all that could be used with advantage and economy. The experiments abroad in the meanwhile, however, demonstrated the necessity of making some changes and improvements in their offensive and defensive qualities, and much delay in their completion was the result.

The exact size and type of turrets and guns remained unsettled for some time. The question also as to whether it was advisable or not to build a house or superstructure on the deck between the turrets to accommodate the officers was undecided for quite a time. Therefore, in view of these uncertainties, I omitted in the calculations the turrets and house, also the armored stack and ventilator, in the stability work. Under such circumstances it was also impracticable to determine with certainty the exact vertical location of the center of gravity of the whole complete vessel. These conditions, however, did not prevent the assumption of the center

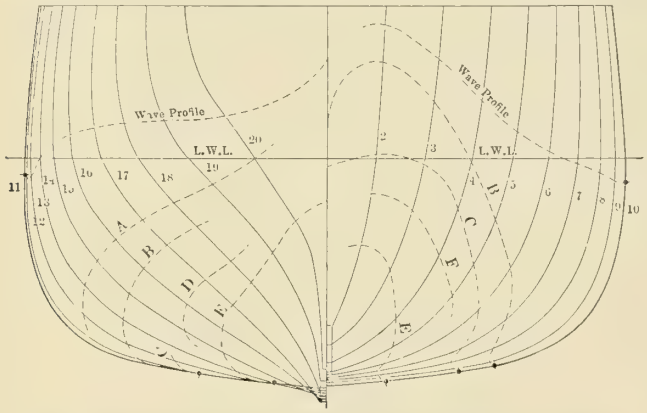
of gravity in several places, as shown on the curves. And it was hoped on final completion that the vessel would be heeled. This would have enabled one to determine the actual curve in short order; but this opportunity never occurred to me.

An Experimental Investigation of Stream Lines Around Ships' Models.*

BY D. W. TAYLOR, NAVAL CONSTRUCTOR, U. S. N.

One of the investigations carried on at the United States experimental model basin during the past year has been into the question of stream lines or lines of flow around ships' models. These flow lines must be practically the same for ship and model, and a knowledge of them is important in determining the locations of bilge keels, docking keels, etc.

Several different methods of investigation were tried, all, however, upon the same principle. The details of the method finally adopted as the best are due largely to Mr. E. P. Lesley, who was detailed on this work for some time. The surface of the wooden model is coated on one side with hot glue



BODY PLAN OF UNITED STATES PROTECTED CRUISER SAN FRANCISCO.

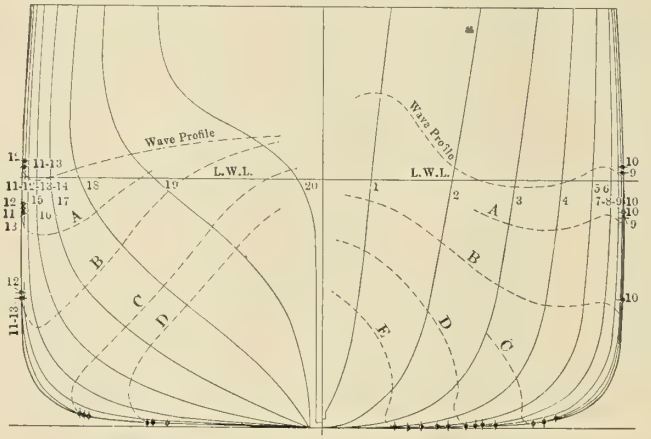
applied with a brush. Before this sets it is painted over with a strong solution in water of sesqui-chloride of iron (Fe_2Cl_6). It is allowed at least 24 hours to set and harden. The model is then put into the water and towed at the speed corresponding to that of the full-sized ship.

To trace a stream line, a small hole is bored through from inside or, in the case of extremities, from the opposite side of the deadwood, and a strong solution of pyrogallic acid [$C_6H_3(OH)_3$] is injected through the hole while the model is under way. A solution containing 10 ounces of acid to a gallon of water, which was about the strongest solution used, has a specific gravity of 1.03. This is instantly largely diluted by the water as it passes through the hole in the model, and flows aft as part of the water. The particles of pyrogallic acid which come in contact with the coating of chloride of iron combine to form ink. The result is a dark streak or smudge on the surface of the model, which widens as it passes aft, and is of such a nature that its center line, which is taken as the stream line past the hole, can be located with a good deal of accuracy—say, within a quarter of an inch for a distance of from 2 to 4 feet abaft the hole. After each run the model is lifted from the water, the stream line located as far as possible and marked, and a new hole bored at the after portion of it for the next run. The process is not a rapid one, even when several stream lines are being carried aft at once, and it takes about a day to determine half a dozen lines of flow from stem to stern of a good-sized model.

The wave profile against the side can be determined similarly by dropping a little acid into the water close to the side; but, since ripples cause the water to wet the side above the true mean surface, the wave profile thus determined is apt to be from ⅛ to ¼ inch above the true mean wave surface. The wave shape, however, is quite accurately given.

The table gives the dimensions and data for seven ships whose models have had their stream lines determined as described above, and the figures give the stream lines past the models. Each line is distinguished by a letter, which is necessary, since some lines extend from stem to stern, while others were traced for short distances only.

Each of the seven vessels is of a different type, except the *San Francisco* and *Baltimore*, and their speeds in proportion to their lengths vary, as indicated by the varying speeds of the 20-foot models. The *San Francisco* and *Baltimore* are old



BODY PLAN OF UNBUILT COLLIER, UNITED STATES NAVY.

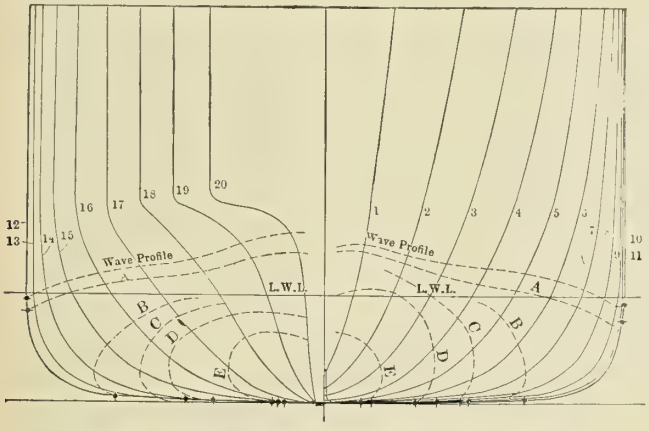
protected cruisers of the United States navy. The collier is a model of a collier designed for the navy, but not built. The *Sotoyomo* is a navy tug, which has great beam in proportion to length. Number 5 represents a shallow draft river steamer, which has great beam in proportion to its draft. Number 6 is a very full vessel driven at low speed and having a parallel middle body. Number 7 does not represent an actual vessel, being a model with a swollen amidship section.

* Read before the Society of Naval Architects and Marine Engineers, New York, Nov. 21, 1907.

No.	Vessel.	Ship.					Model.				
		Length on L. W. L. Feet.	Breadth on L. W. L. Feet.	Mean Draft. Feet.	Displacement in Salt Water in Tons.	Speed in Knots.	Length on L. W. L. Feet.	Breadth on L. W. L. Feet.	Mean Draft. Feet.	Displacement in Fresh Water in Pounds.	Speed in Knots.
1	*San Francisco*	310.0	48.76	18.94	4,098	19.52	19.900	3.146	1.222	2,398	5.00
2	*Baltimore*	327.5	48.93	20.08	4,570	20.10	20.000	2.988	1.226	2,267	4.97
3	Collier	460.0	61.70	25.82	15,000	15.00	19.745	2.648	1.108	2,582	3.11
4	*Sotoyomo*	94.64	21.03	9.16	258	10.31–5.50	19.555	4.346	1.893	4,955	4.69–2.50
5	Shoal draft river steamer	257.0	30.58	5.54	661.5	19.00	20.000	2.380	0.431	679	5.30
6	Great Lakes ore steamer	540.0	55.57	19.50	14,505	10.42	20.000	2.058	0.722	1,605	2.05
7	Special Type	490.25	81.70	22.40	14,750	19.00	20.546	3.424	0.939	2,361	3.89

An examination of the figures discloses at once a condition of affairs very different from what is often supposed to be the case. The general assumption has been, I believe, that the water would part more or less horizontally forward, follow a diagonal amidships, and aft would flow up from below. The figures show, however, that the water forward does not flow away horizontally, but insists upon passing under the vessel, and by no means along a diagonal. Consider, for instance, the line *B* in Fig. 1. On station 2 this line is nearly 40 percent of the draft of the ship above the original load waterline. Yet amidships this line has found its way clean under the bottom, following practically a vertical line for a respectable portion of its course. This general phenomenon is found in every case—even in the case of the abnormal type of model number 7, which was tested with the idea that if the water would part horizontally for any type of model, it would do so for the model number 7. It is seen, however, that even here the water finds its way under the bottom of the vessel. The figures, with one exception, refer to one speed in each case, being about the maximum speed attained by the vessel, or which might be expected from it. The *Sotoyomo* model, however, was tried at two speeds, one corresponding to the full speed of the ship and the other corresponding to a very low speed. The stream lines are seen to be not very different, the differences which manifest themselves being clearly explicable by a consideration of the difference in surface disturbance.

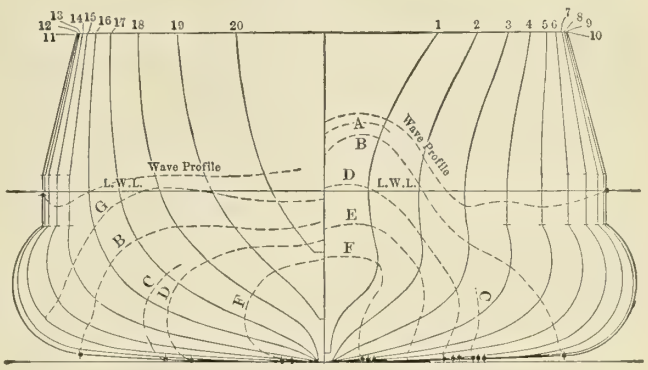
Careful investigation of the figures will show that the waves on the surface apparently influence the stream lines to a remarkable depth. In a number of cases it will be found, on following up the sections to the surface, that apparent eccentricities in the stream lines correspond to hollows in the wave profile.



BODY PLAN OF FAST, SHALLOW-DRAFT RIVER STEAMER.

In the lake steamer, a vessel with a long parallel middle body, the lines of flow over this parallel middle body are not parallel to the axis. Spots are given showing where each flow line cuts the various stations of the parallel middle body. It is seen that line *E*—the inner line—steadily works outward as it passes aft along the parallel body. The lines above the turn of the bilge indicate wave motion, although, as it happened for this model, with its low speed, the wave line was practically level over the forward portion of the parallel body. Model 3 of the collier, which is rather flat, has almost a parallel middle body and shows somewhat the same features.

The general features of the stream lines around models have been confirmed by a number of experiments with other models, and, I think, indicate that the commonly accepted notion as to the flow of water around the fore body of a ship is erroneous. Indeed, upon reflection, it is difficult to see how it would be mechanically possible for the water to flow out horizontally from the fore body and up vertically around the after body. Were this the motion, how could water be gotten



BODY PLAN OF SPECIAL FORM, MODEL NUMBER SEVEN.

down below to take the place of that which flows up around the after body? If, however, we consider that the water flows down forward, passes under the ship and then comes up again, we have a motion which is evidently mechanically possible.

It may be remarked, in conclusion, that these stream lines, experimentally determined around models, show, broadly speaking, a remarkably close agreement with theoretical stream lines past submerged solids.

Test on the Steamship Governor Cobb.*

BY PROF. W. S. LELAND AND H. A. EVERETT.

The test on the steamship *Governor Cobb,* of the Eastern Steamship Company, was run on the regular trip from Boston to St. John, via Portland and Lubec. Observations began on passing Boston Light, and were continued for 26 hours: for the boiler test continuously; for the engine test at favorable times. All observations were plotted, which presents an interesting study of the results, and makes simultaneous readings possible with a limited corps of observers. The close agreement of these curves is a good check on the accuracy of the observations.

The horsepower was determined by means of the Denny and Johnson torsion meter belonging to the United States ship *Chester,* which was loaned by the Navy Department. The torsion meter was set up in the engineering laboratory, and a thorough working knowledge obtained by the use of experimental apparatus, before installing the meter on board. Thirty-six feet on the side shafts, and 49 on the center shaft between inductors, was the greatest length obtainable, which gave a meter reading of about 0.50 and 0.73, respectively, at full power.

In computing the horsepower, 1.506, based on an assumed torsional modulus of elasticity of 11,600,000, was used for the constant *K* in the formula:

$$\text{H. P.} = \frac{Kd^4rR}{CL}$$

in which d = diameter of shaft in inches (6⅜); r = torsion meter reading; R = revolutions per minute; C = inductor constant (12.5); L = length of shaft in feet between inductors.

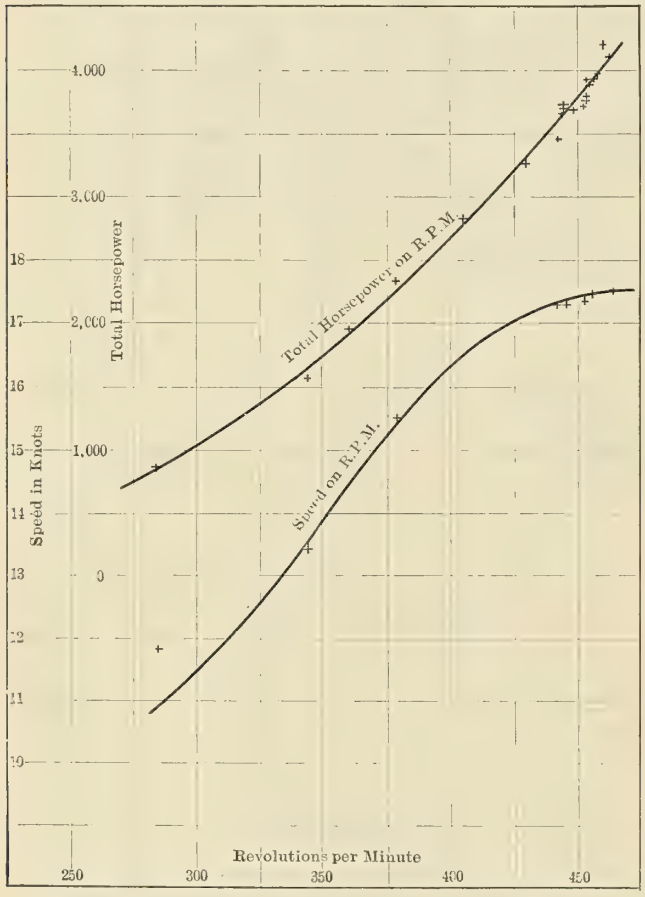
The water consumption was measured by a hot-water meter loaned by the Hersey Manufacturing Company, of South Boston. It was installed in the suction line between the hot well and the feed pump, and gave exceedingly satisfactory results. This meter was later calibrated under similar conditions. The plot of meter readings was struck in as a straight line, showing practically a uniform rate of consumption, no point varying from the line by a quantity greater than 1 percent of the total.

The steam for all auxiliary purposes was passed through the two auxiliary lines, one on each side of the vessel, and the

* Read before the Society of Naval Architects and Marine Engineers, New York, November 22, 1907.

quantity measured by its flow through orifices. A thin steel plate having a hole 1⅝ inches in diameter was inserted in each auxiliary line between two flanges near the boiler. Pressures were read simultaneously at both orifices, and at no time showed a variation of over a pound after making the proper gage corrections. The orifice was afterwards set up in the laboratory, and its coefficient carefully determined by actually weighing the condensed steam under conditions similar to those on the boat.

Several buckets of coal were weighed, and their average, which varied only 10 pounds from either maximum or minimum, multiplied by the number of buckets, was taken as the



SPEED AND HORSEPOWER PLOTTED ON REVOLUTIONS PER MINUTE.

coal consumption. The plot of coal consumption, like that of the water, is a perfectly straight line, showing a uniform rate.

The run from Boston to Portland was largely consumed in a progressive trial, the speed being taken by a stop-watch and a McGray electric log towed from the end of a boom well clear of the wake. The log had previously been calibrated by towing over the measured mile. Results of speed and power are shown in the curves.

The best run was made at full speed between Portland and Lubec, under the most favorable conditions of weather and sea. All observations were taken at 10-minute intervals, excepting the coal, which was recorded every 15 minutes. An attempt was made to determine the quality of steam, but as there were objections to tapping the main pipe, a sample was taken from the drip connection, which showed 2.5 percent of moisture, which is more than would be obtained from a fair sample.

It may be of interest to compare the following tabulated results with similar results obtained from a test on the steamship *Nantucket,* of the Merchants' & Miners' Transportation Company:

RESULTS OF TEST

	Nantucket	*Governor Cobb*
Date of test	Feb. 7, 1904	April 18, 1907
Duration of test—boiler	20½ hrs	8 hrs.
Duration of test—engine	20½ hrs.	4 hrs.
Boiler pressure (average gage)	147.3 lbs.	128 lbs.
Quality of steam (sampled at drip)	98.8	97.3
Barometer	14.7 lbs.	14.7 lbs.
Temperature of air pump discharge	.....	110° F.
Temperature of feed water	209.4° F.	213° F.
Kind of coal used	Georges Creek	Cape Breton
Moisture in coal	2%	1.9%
Ash and clinker in coal	7.6%	6.8%
Draft at blowers	Natural	2.1 inches
Number of boilers (single-ended Scotch)	4	6
Total grate surface	320 sq. ft.	323 sq. ft.
Total heating surface, approximately	10,150 sq. ft.	12,000 sq. ft.
Ratio, heating to grate	31.7	37.2
Coal fired per hour	5,135 lbs.	8,050 lbs.
Water fed per hour (average during engine test)	45,844 lbs.	85,710 lbs.
Coal burned per square foot grate surface	16 lbs.	24.64 lbs.
Maximum revolutions	.....	p. 475, s. 460 c. 440
Corresponding total shaft horsepower	.....	4,100
Average revolutions	74.05	447
Average total horsepower	2,362	3,747
Steam for auxiliaries	.....	38,360 lbs.
Steam per I.H.P. per hour, total	19.41 lbs.	.....
Steam per brake horsepower per hour, total	.....	22.87 lbs
Propelling machinery only	.....	19.74 lbs.
Speed (average) in knots	15.00	17.21
Type of engine	Reciprocating	Turbine
Vacuum in inches	25	27
DIMENSIONS		
Length between perpendiculars	274 ft.	290 ft.
Beam molded	42 ft.	51 ft.
Draft	15 ft.	14 ft.
Displacement	2,700 tons	.....

The Merchant Marine of Japan.

The annual appropriation for promoting shipping and aiding lines of the merchant marine for the fiscal year ended March 31 last (subsidy) was $3,526,559 (£724,660), as for several preceding years. The appropriation for aiding shipbuilding was $399,250 (£82,040). For the current fiscal year, and for several succeeding years, additional subsidies have been guaranteed, amounting to $784,136 (£161,129) per annum, more than half of which is for lines to China.

The Japanese merchant marine in 1880 amounted to 63,486 gross tons; in 1890, the figure was 157,365 tons, or a gain of 148 percent. By 1900 the tonnage had risen to 840,632 tons, or a further gain of 434 percent. In the middle of 1906 the figure was 1,309,579 gross tons. This has been further increased since that date, there being on December 31, 1906, 1,446 steamships, aggregating 1,034,634 tons, or an average of 715. In addition to these, there were 4,044 sailing vessels of foreign model, amounting to 346,260 gross tons, or an average of 86 tons. This makes a total of 1,380,894 tons.

Of the steamships, 21 exceed 6,000 tons, and the number of large vessels is rapidly increasing. The dockyards of Nagasaki, Kobe and Uraga are very busy, having 60,000 tons on the stocks, and 50,000 tons more in prospect. Of the new steamers, six of 8,000 tons each are building for the Nippon Yusen Kaisha, and it is stated that a regular line between Japan and New York by way of Suez is to be established.

THE HAMBURG-AMERICAN STEAMER KRONPRINZESSIN CECILIE.

BY F. C. GUENTHER.

THE PROPELLING MACHINERY.

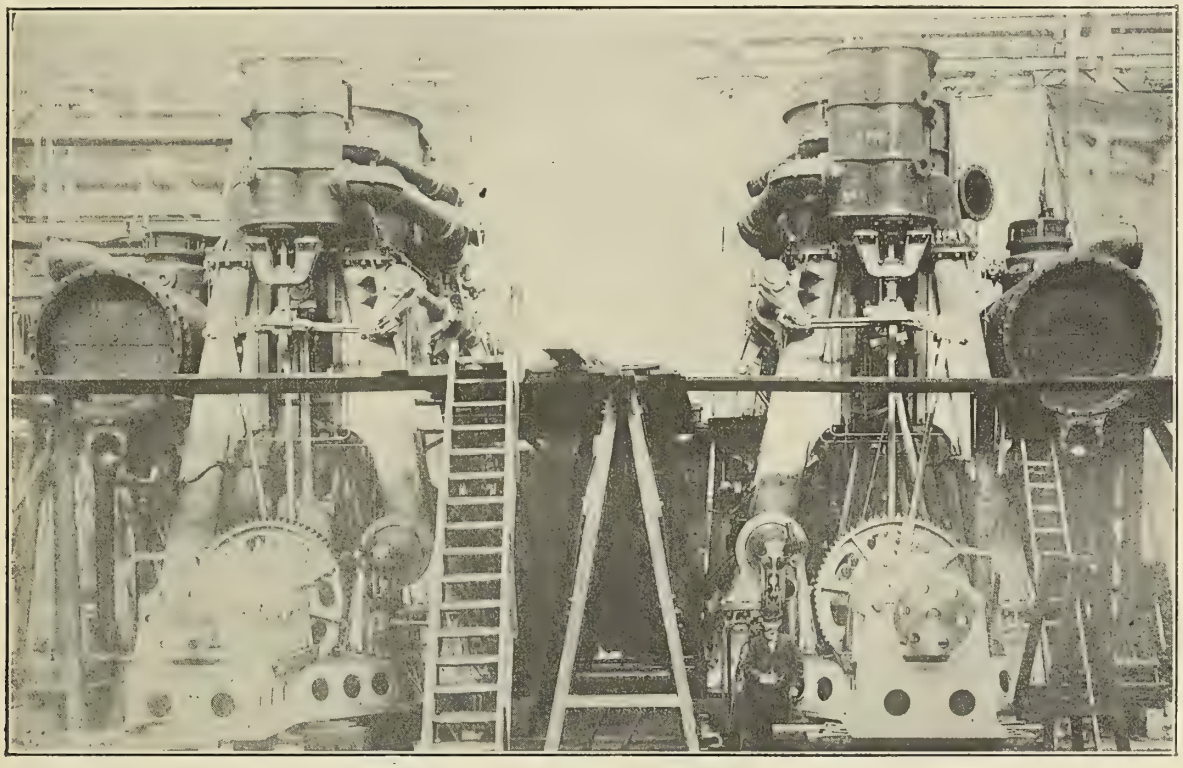
There are two main engines of the four-cylinder, vertical, inverted, direct-acting, quadruple expansion type, balanced according to the Schlick system, and each capable of developing about 3,035 indicated horsepower at 79 revolutions per minute, and a steam pressure of 214 pounds per square inch. The sequence of the cylinders, beginning forward, is high-pressure, second intermediate-pressure, low-pressure, and first intermediate-pressure, with, respectively, 23⅝, 50 3/16, 73 13/16, 34 7/16 inches diameter, and a common stroke of 53 15/16 inches.

The cranks follow each other in the regular order of size of cylinders, the high-pressure being followed by the first intermediate, the second intermediate, and then the low-pressure. On account of balancing, these cranks are not at right angles, the angle between the high-pressure and first intermediate being about 65 degrees. Between the first and second intermediate cylinders is an angle of about 95 degrees; between the second intermediate and the low-pressure, 105 degrees; and between the low-pressure and the high, again, 95 degrees.

The high-pressure and the first intermediate cylinders have each one piston valve, with mean diameters, respectively 10⅜ and 17⅛ inches. The two larger cylinders have flat double-ported slide valves. The valve stems are in all cases of a diameter of 4⅛ inches, while the piston rods have each a diameter of 6⅝ inches. The two large cylinders have tailrods 4 7/16 inches in diameter. All valves are operated by Stephenson link motion from eccentrics, and can be worked by both steam and manual power. The valve strokes are, respectively, 7⅛ and 8¼ inches, for the piston and slide valves.

The main engines are in a single engine room without center line bulkhead, the starting platforms being conveniently located between the engines, with ample space for the engine crew to work in. The cylinders are safely bolted together, but there is no rigid fastening between them, thus allowing fore-and-aft play for expansion. Each of them is fitted with safety valves in the bottom and cover. They are supported by hollow cast iron box columns, and these, in the neighborhood of the engineers' platforms, are utilized for oil storage and provided with taps and pipes for filling them, and for drawing off oil as needed. All stuffing-box packings of the main engines, the pistons and the valve rods are metallic packings of the United Kingdom type, whereas all piston rods, pistons and slide rods of the auxiliary engines, winches, etc., are provided with Garlock (Palmyra, N. Y.) packing.

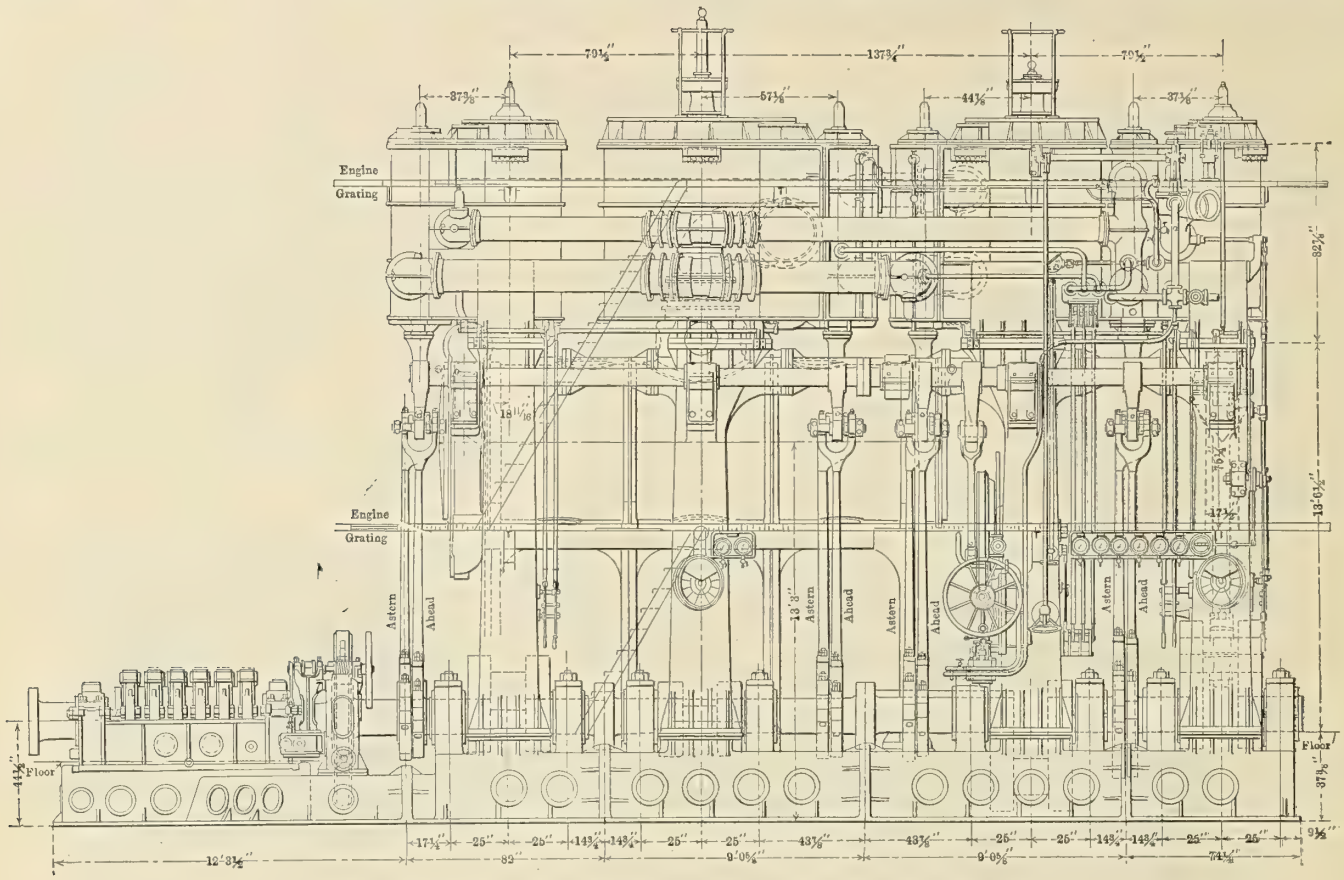
The main steam pipe has a diameter of 8¼ inches. The pipe carrying steam from the high-pressure to the first intermediate cylinder is 9 7/16 inches in diameter. The pipe next in order has a diameter of 13 inches, which is also the diameter of each of the two pipes carrying steam from the second intermediate to the low-pressure cylinder. The exhaust pipe has a diameter of 23¼ inches.



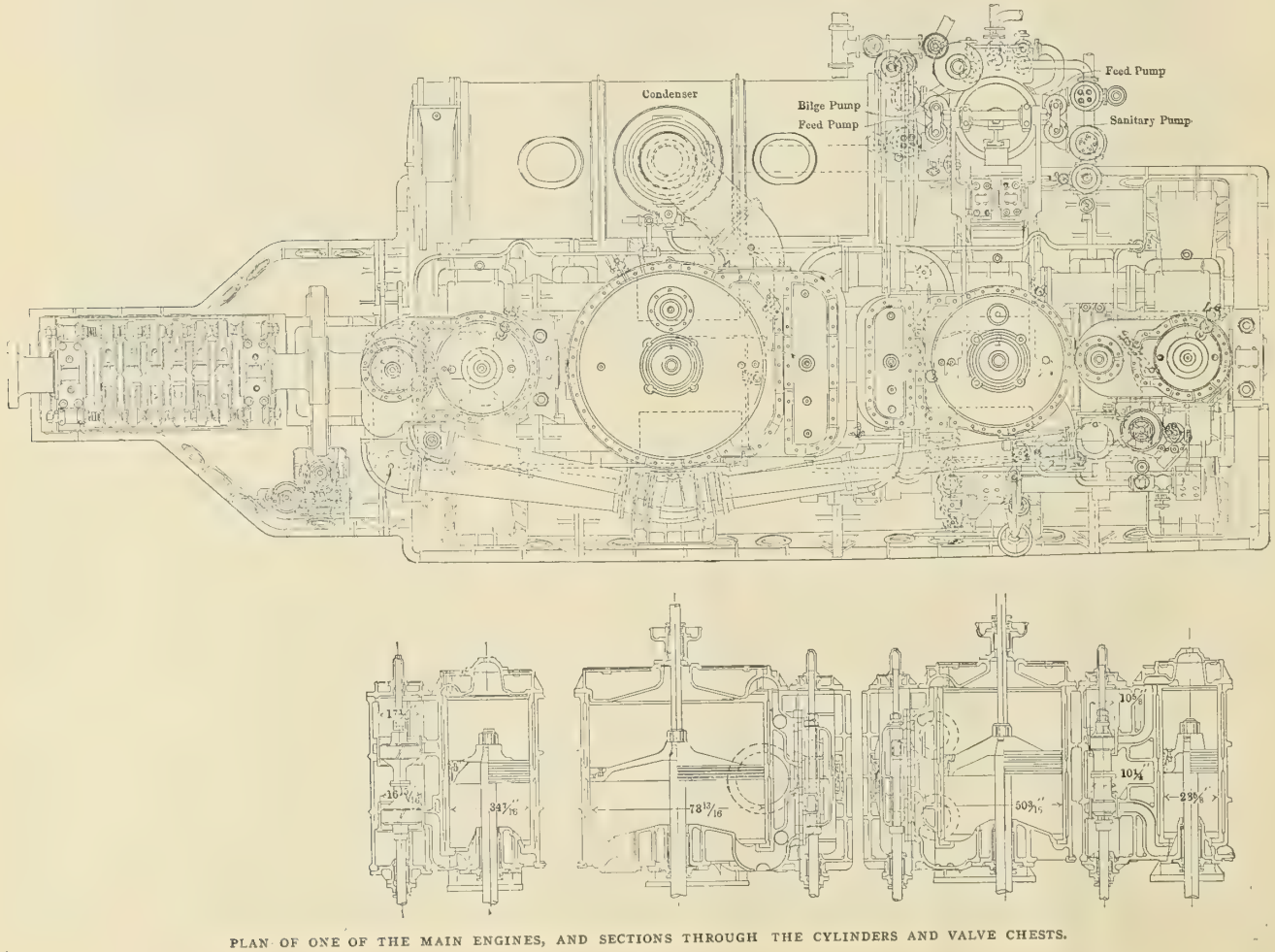
PROPELLING ENGINES OF KRONPRINZESSIN CECILIE, ERECTED IN BUILDERS' SHOP.

The shafting, which is made of best steel, has a tensile strength of 25.4 to 29.4 tons per square inch, and an elongation of 20 to 25 percent. The crankshaft diameter is 14 13/16 inches, thrust shaft 14 13/16 inches, line shaft 14 inches, and propeller shaft 15 3/16 inches. The flange couplings are 28 inches in diameter and 4⅛ inches thick. The crank pins are 15 3/16 inches in diameter.

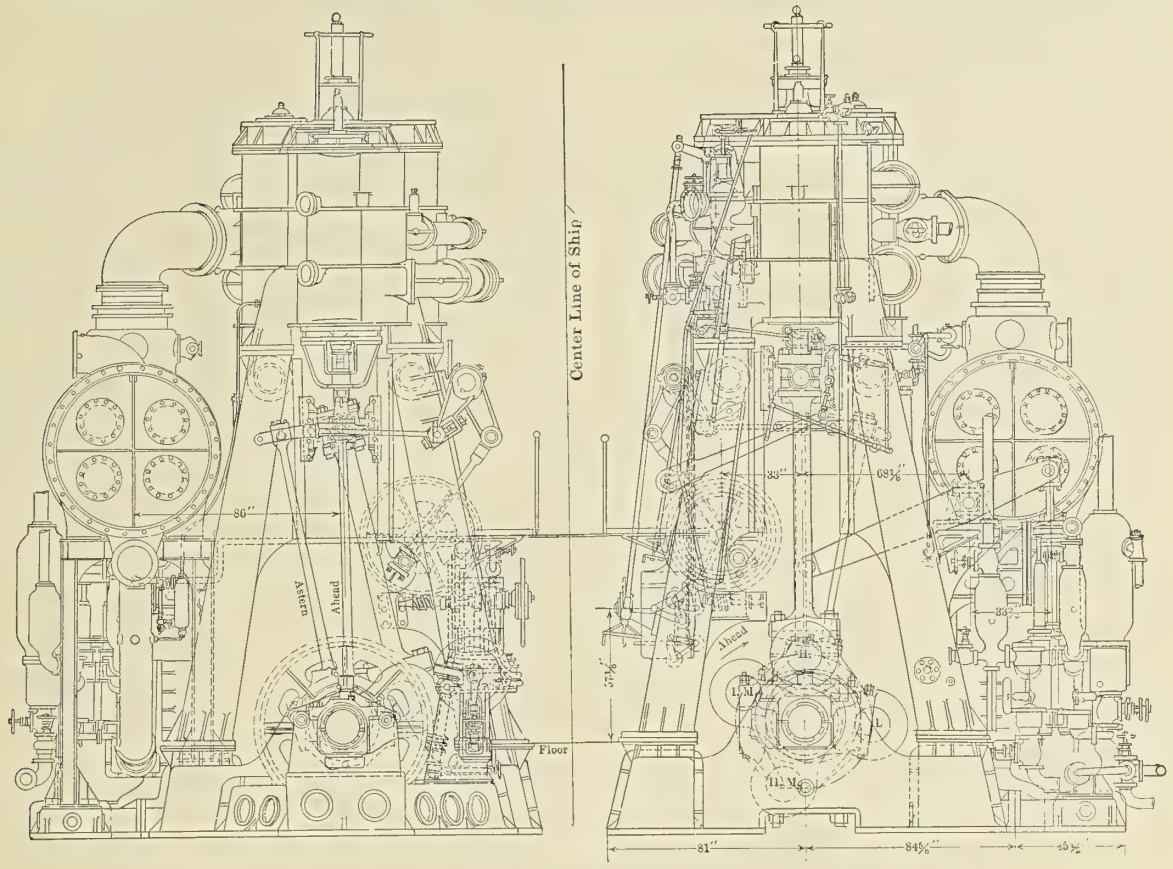
The two propellers, which are four-bladed, of the built-up type, turn outboard when going ahead. They are of manganese bronze, and have a diameter of 17 feet ¾ inch, and a pitch of 20 feet 4⅛ inches, the pitch ratio being 1.192, as set. This corresponds with point *A* in the drawing of blade setting. When the blade is set at *B*, the pitch is 18 feet 8⅜ inches, and the pitch ratio is 1.096; similarly, the pitch becomes 22 feet 3¾ inches, and the ratio 1.308, when the blade is set at *C*. These



ELEVATION OF THE PORT ENGINE AND THRUST BEARING FROM THE INBOARD SIDE.



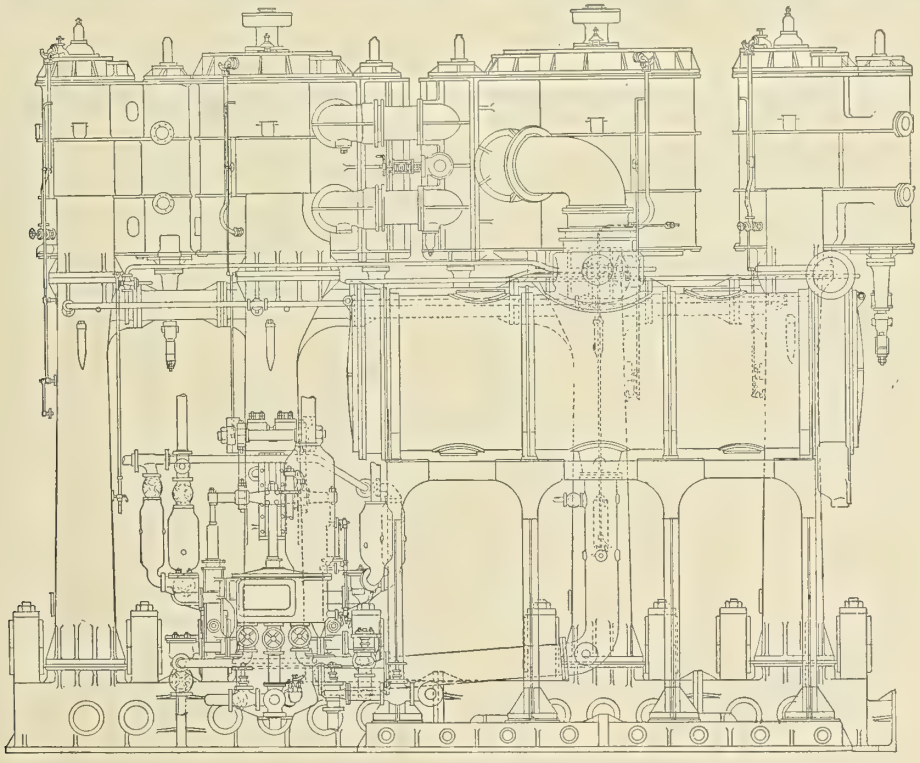
PLAN OF ONE OF THE MAIN ENGINES, AND SECTIONS THROUGH THE CYLINDERS AND VALVE CHESTS.



END VIEWS OF THE MAIN ENGINES, ONE FROM FORWARD, THE OTHER FROM AFT.

points are, respectively, the centers of the studs joining the propeller blades to the boss, and are located at intervals of 7/16 inch.

The projected surface of each propeller is 59.2 square feet, the developed surface 85.23 square feet, and the ratio of projected area to disk area 0.26. The hub, which is made of cast steel, has a diameter of 3 feet 11 11/16 inches, and is lined with zinc plates as a precaution against corrosion. The propeller blades are pitched aft, the axis of the blade at the tip being 17¾ inches aft of the axis of the propeller as a whole. The propeller shaft enters a conical seating in the hub, having a diameter at the forward end of 15½ inches, and at the after end of 12½



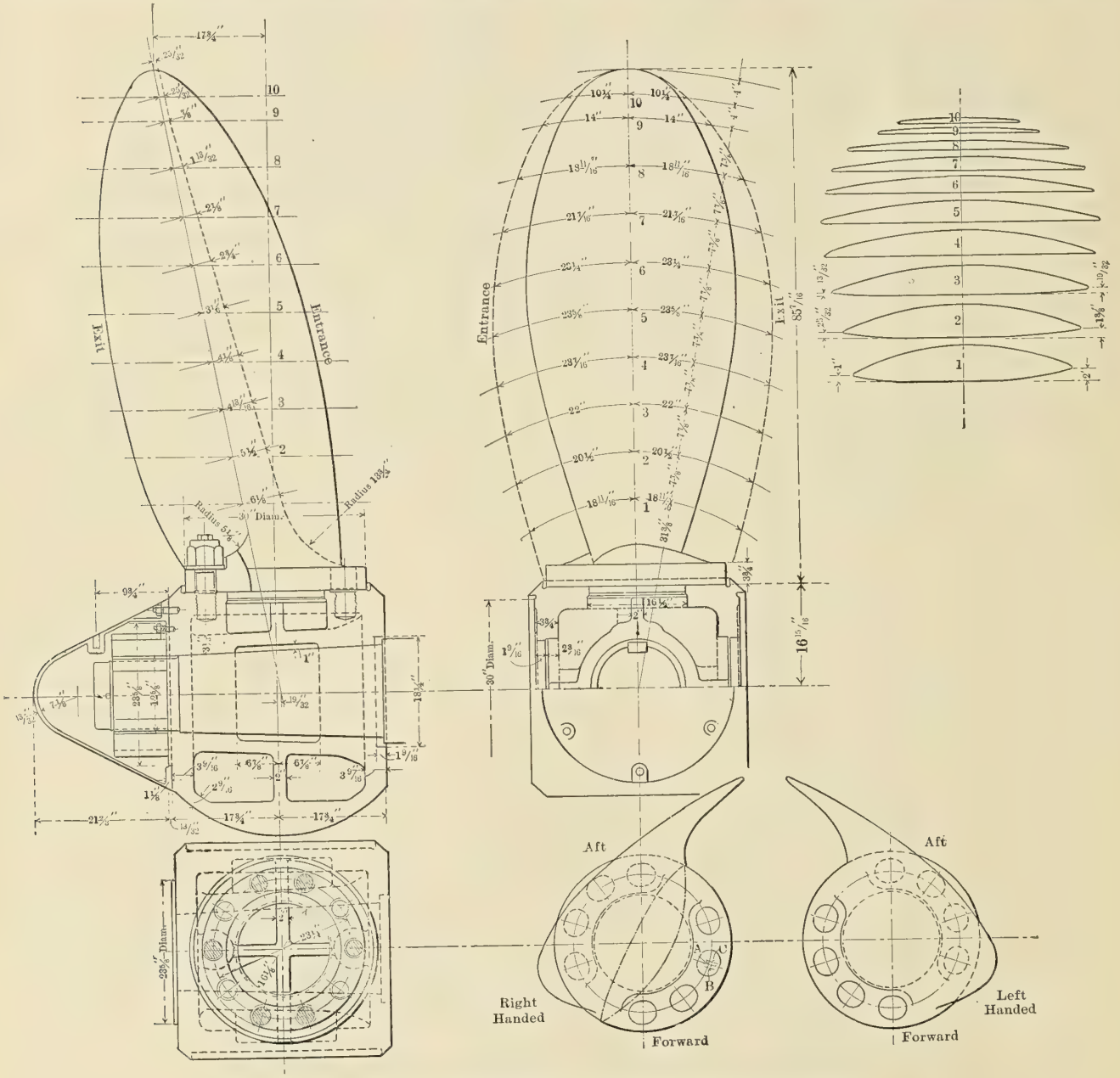
BACK ELEVATION OF THE PORT PROPELLING ENGINE.

inches. This conical portion has a length of 35 inches. A cap, covering the end of the shaft, protects the nut which holds the propeller in position. Each blade is fastened to the hub by means of four studs.

THE BOILERS.

Three double and one single-ended boilers of the cylindrical type, working at a pressure of 214 pounds per square inch, are located in one boiler room, and have a single funnel. There are three furnaces at each end of the double-ended boilers, and at the front of the single-ended one, making a total of twenty-one fires. The furnaces have internal and maximum diameters of 3 feet 9¼ inches and 4 feet 1¼ inches. The thickness is ¾ inch. The grates are 5 feet 5 inches in length, the grate surface for each double-ended boiler being 128.1 square feet, while the heating surface in each of these boilers figures out at 5,382 square feet, or a ratio of 42 to 1. The grate surface of the single-ended boiler is 64.6 square feet, and the heating surface 2,152 square feet, which makes an aggregate grate surface of 448.9 square feet, and a total heating surface of 18,298 square feet, or 40.7 to 1 of grate.

The double-ended boilers have a length over the ends of 20 feet 5½ inches and are made in three courses, two being outside and one inside. The outside diameter is 15 feet 10 inches, while the thickness of the plates is 1.6 inches. Each boiler contains three Morison suspension furnaces in each end, with a separate combustion chamber for each pair of furnaces opposite each other. The length of tubes between tube sheets is 7 feet 10½ inches, and they are spaced 4 inches apart in each direction. Each end of each double-ended boiler contains 414 tubes, of which 184 are stay-tubes and 230 are ordinary tubes. All have an outside diameter of 2¾ inches, with a thickness of 0.315 inch for the stay-tubes, and 0.1575 inch for the others. The front tube sheets have a thickness of 1.06 inches, while the back tube sheets are 1.02 inches thick.



LAYOUT OF ONE OF THE SCREW PROPELLERS, WITH DETAILS OF HUB AND BLADES.

The tops of the combustion chambers, ⅜ inch thick, are supported by the usual bridge girder, there being four on the central chamber and five on each of the side chambers. Each carries six supporting bolts. Each of these girders, with the exception of the one in each case nearest the shell in the side combustion chambers, is supported in turn by two sling stays 2½ inches in diameter, and carried each on a continuous pair

of double angles 6 by 6 by 1 inches, riveted to the shell. The spacing of the screw stay-bolts in the combustion chambers is 7½ inches in each direction. These bolts are 1¾ inches in diameter.

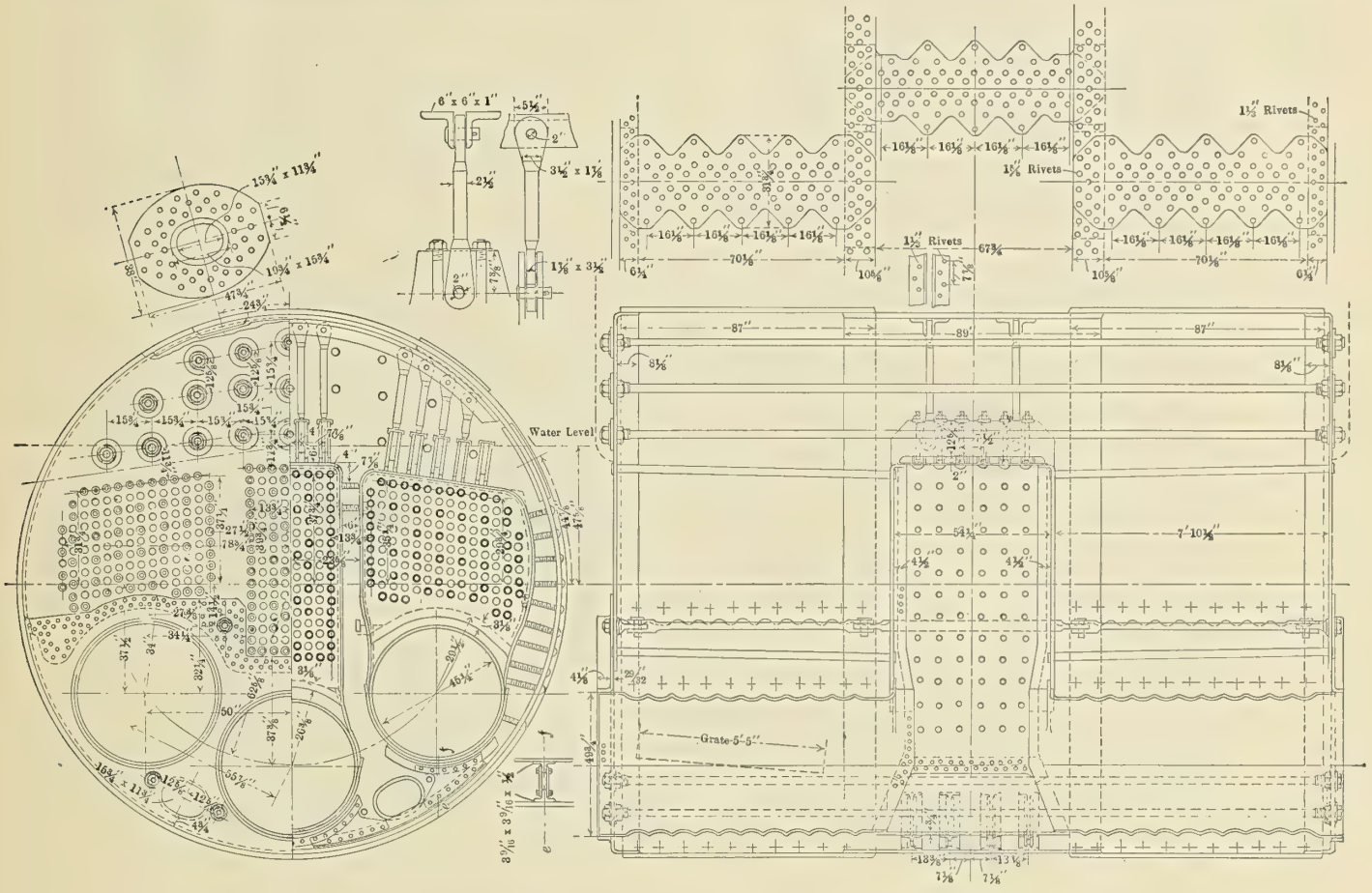
Above the combustion chambers are twenty-one through stays, of which fourteen have each a diameter of 2⅞ inches and are provided with washers 10⅝ inches in diameter, while the others have a diameter of 2½ inches and have 10¼-inch washers. In the lower part of the boiler are six stays of the latter size, of which four are through stays, while the other two, passing between the combustion chambers, are made up of three sections swiveled together.

Each course of the boiler is made of a single plate, with a butt joint and double butt straps, the latter having a thickness of 1¼ inches. The strength of the outer courses in the boiler shell has been computed as 90 percent of the uncut sheet, and the inner course is given as 88.15 percent, with a thickness a trifle greater than the outer. The riveting has been done so completely as to furnish a rivet strength in excess of that of the unbroken shell by about 25 percent. The shell steel has been subjected to tests which show a tensile strength of 66,850 pounds per square inch, with an extension of 20 percent in 8 inches. The remaining plates show a strength of about 60,000 pounds per square inch, with an extension of 25 percent. The rivet material shows a strength of 62,500 pounds per square inch, with an extension of 20 percent. The plates are of Siemens-Martin mild steel, and the riveting, wherever possible, was done by hydraulic process.

The funnel, which has a circular section, consists of an inner and an outer tube, with sufficient air space between them, the diameters being 10 feet 2⅛ inches and 12 feet 9¾ inches, respectively. Howden's forced draft is used, and two ventilators of 2 feet 11½ inches in diameter are provided for each fire side in the boiler room.

THE AUXILIARY MACHINERY.

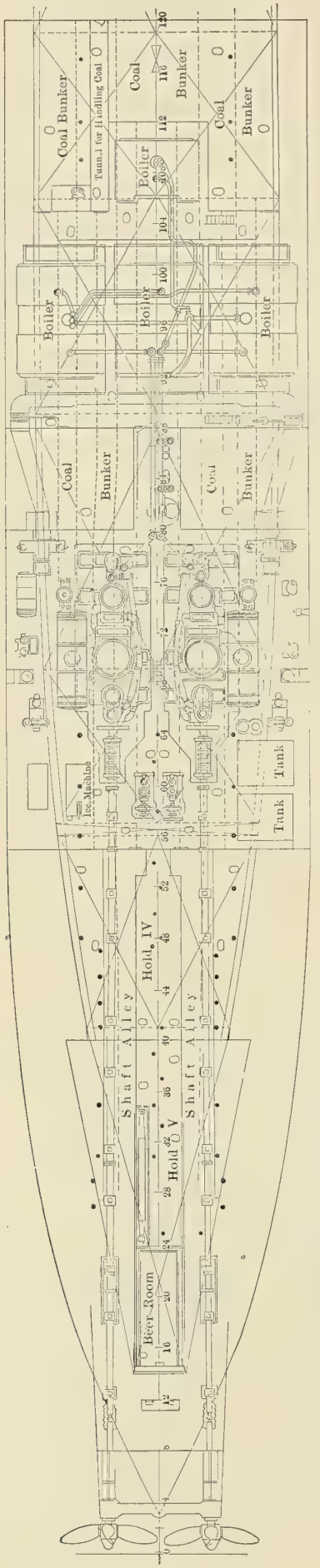
The two main condensers have cooling surfaces amounting to 4,413 square feet each, while the auxiliary condenser has a cooling surface of 861 square feet. The cooling pipes, of the Everrett system, are of brass, tinned inside and outside, with a diameter of ¾ inch. The air pumps, of Edwards type, measure 23⅝ inches in diameter, with a stroke of 26 9/16 inches. The pump barrel is a bronze casting ¾ inch thick, the piston rod is of Parsons manganese bronze, and all the valves are of Kinghorn make. Each main condenser is fitted with one circulating pump of 150 revolutions per minute, of sufficient capacity to deliver the cooling water required for both engines when working with full steam.



SECTIONS THROUGH ONE OF THE DOUBLE-ENDED BOILERS, WITH DETAILS OF RIVETING, MANHOLES AND SLING STAYS.

Two feed-pumps for each engine are fitted, to be used when needed for boiler feed; they consist in all their parts of bronze, and have a plunger of 4 inches diameter, the stroke being 26 9/16 inches. There are fitted two single-acting bilge pumps, and two pumps for sanitary purposes of the same stroke as the feed pumps, and with cylinders 5 inches in diameter. The pump barrel of the bilge pumps is of iron and the plunger of brass.

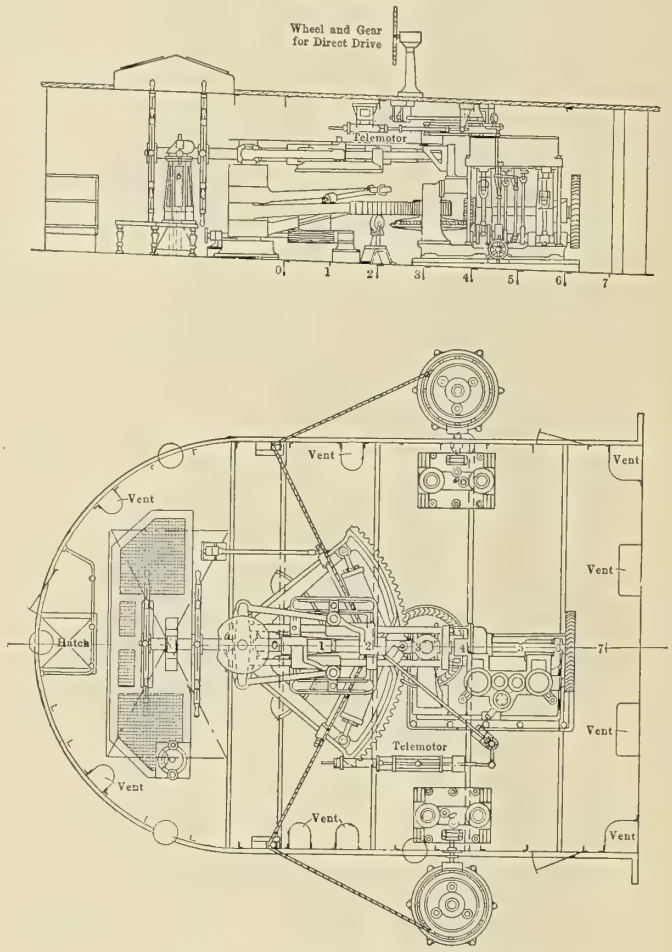
Besides these are two evaporator pumps 2 by 11¾ inches; one vertical ballast duplex pump 10 and 11 by 12 inches; two G. & J. Weir (Cathcart, Glasgow) pumps, each with a capacity of 50 tons per hour; and two duplex steam pumps 6 and 4 by 6 inches, which are used to draw drinking water, either from the tanks of the double bottom into a tank



THE PROPELLING MACHINERY LAYOUT OF THE SHIP COVERS, ALTOGETHER, 275 FEET, INCLUDING BOILERS, ENGINES, PROPELLERS AND COAL BUNKERS.

arranged in the engine room, or directly into a tank on the promenade deck. In addition to these pumps there is a circulating pump for the auxiliary condenser, of the same construction as the main circulating pumps, worked at 200 revolutions per minute.

The two starting engines have each two cylinders of 5⅛ inches diameter, with a stroke of 5⅛ inches. The turning engines have each one cylinder 6 by 4¾ inches. The steam steering engine, from Caldwell & Company, has cylinders of 12 inches in diameter, with a stroke of 12 inches. Among other auxiliary engines there are one for the anchors; eight cargo winches, four 7 by 12 inches and four 6 by 10 inches;



ELEVATION AND PLAN OF THE STEERING GEAR.

two steam capstans and a refrigerating engine working on the J. & E. Hall (Dartford, Kent) carbonic acid system.

The *Kronprinzessin Cecilie* is lighted throughout by electricity, which is generated by three dynamos supplied by the Allgemeine Electricitaetsgesellschaft, of Berlin. The engines driving these generators are of the compound type, furnished by Daevel, of Kiel, and are directly coupled to the dynamos, which work at 102 volts, and a maximum of 250 revolutions per minute, the output of each dynamo being 400 amperes. Two of these engines are placed aft in the main engine room, and the third is above the waterline, in a room forward of the engine hatch, on the upper deck. The total number of lamps is 1,087, while the electricity is used for a great many other purposes, including the outfit of the gymnasium, a wireless telegraphy equipment fitted in a room of the officers' house on the boat deck, telephones, a complete bell system, and ventilating fans, of which latter there are 188.

MODERN MARINE TRANSPORTATION.

BY WILLIAM T. DONNELLY.*

Modern marine transportation may be said to have begun with the first successful application of steam power to the propulsion of ships, and it would seem almost beyond belief that the present year completes but the first century of its application.

Man, since his advent upon the earth's surface, has followed but two callings—that of war and that of trade. The first has been a calling of destruction and annihilation, the second a calling of construction and production—the one tearing down, the other building up. And if there is one single thing which gives us confidence that the present civilization is to remain upon the earth, it is that transportation is binding all nations into one commercial body. It must be apparent to all broad thinkers that the development of the means of transportation upon the great bodies of water that divide the great nations of the earth has been the incentive to the making of international treaties of peace, which are constantly making war and conquest less and less a normal occupation of mankind.

Great as has been the development of transportation upon the sea, even greater development has been made upon land. The application of steam power to land transportation commenced about the same time, and its development has measured the march of civilization. The savage and the wilderness cannot exist where the railroad penetrates. Up to the present time, land and marine transportation have developed independently, and to a large extent in hostility to each other, although both have been using the same great force.

The railroads, on the one hand, have persistently contended that wherever a line of rails was possible, marine transportation was useless. The exponents of marine transportation have contended, on the other hand, that the railroads simply served the purpose of bringing the materials for transportation to the harbors of the world for shipment. It now appears that land transportation, as exemplified by the railroads of the country, has reached that point in its development where it is more than ready to forget its hostility, and to call upon marine transportation for assistance in handling the transportation of the continent, and this in spite of the fact that it has taken advantage to the fullest measure of corporate organization and such general confidence of the people as has enabled it to call to its aid almost unlimited capital; while, on the other hand, marine transportation in almost every instance has been developed by individual energy, organization and management.

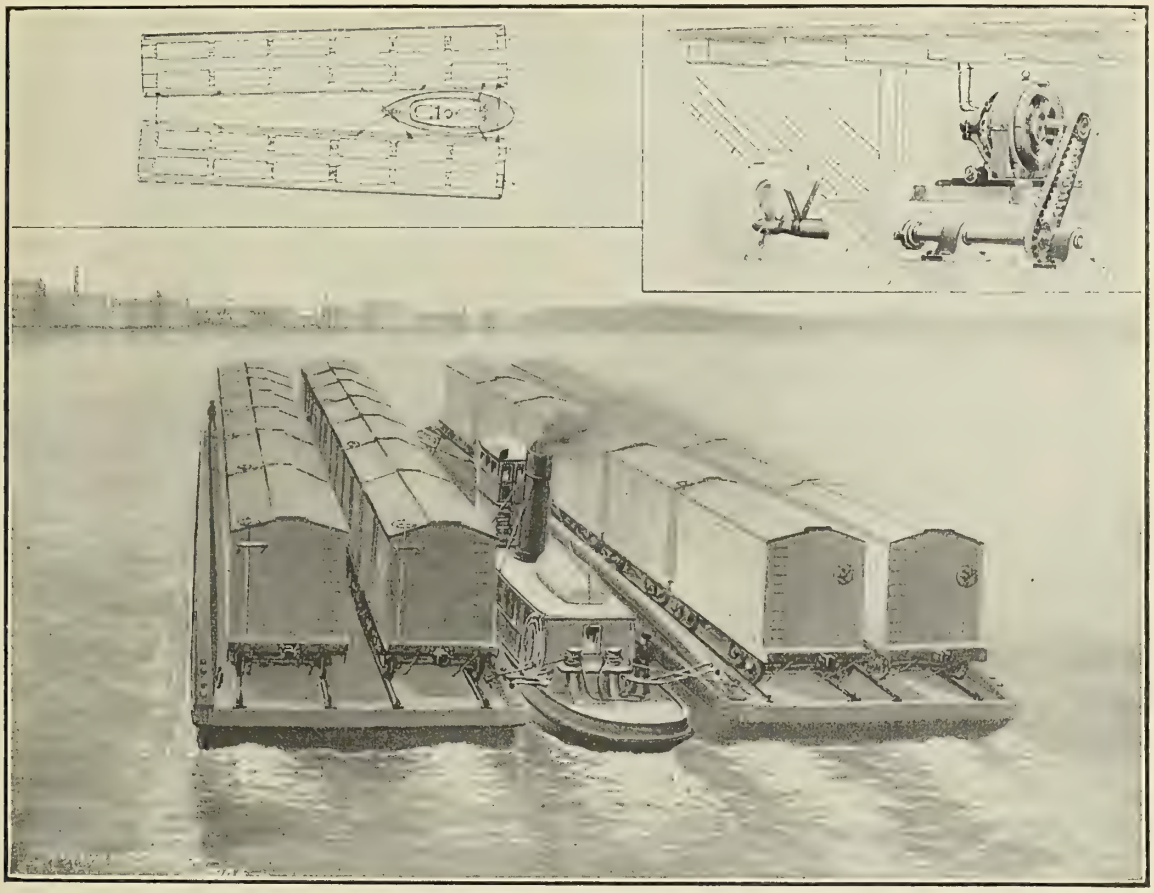


FIG. 1.—MARINE UNIT SYSTEM APPLIED TO CAR FLOAT SERVICE.

THE ELECTRIC UNIT SYSTEM OF MARINE TRANSPORTATION.

This has for its foundation the broad application of the central station idea for the generation of power, its distribution by electricity, and its application to marine transportation. The system is applicable to all classes of marine work.

The marine transportation unit comprises a power vessel containing an electric power generating plant, and a number of cargo carrying consorts, each propelled by electric power furnished from the power vessel. The power plant is of precisely the same construction, operation and control as those used upon land. This power plant has no direct connection, other than electrical, with the propelling power of the vessel in which it is carried, or of any other of the fleet, consequently

*Consulting Engineer, 132 Nassau St., New York.

the generating engines may be operated at a constant speed and in one direction only, which results in a much simpler form of engine, requiring less attendance, and much less liable to derangement while in operation.

The power vessel (see Fig. 4) contains two boilers of the marine type, each of 700 horsepower, and two directly connected electric generating units of 700 horsepower each. The duplication of the boilers and generating plant make total failure of power highly improbable. Heretofore in all marine work there has been the necessity of a concordant action between the pilot house and engine room, to control the vessel; under this system the engine room and power producing plant are entirely separate and independent of the navigation and control of the vessel, the generation and use of the power being entirely separate functions. The power vessel is propelled by twin screws operated by electric motors; the control of these motors is entirely independent of the power plant, and their starting, stopping and reversing will be under the direct control of the navigating officer in the pilot house, without the intervention of bells or signals of any kind.

The power boat is shown in another view, in connection with two car floats. Each of these is provided with twin screws operated by electric motors, and the control of these motors for stopping, starting and reversing is also located in the pilot house of the power vessel, and under the direct control of the navigating officer. The application of the system involves the principle of so distributing the power that each of the units receives the amount necessary to propel it at the same speed, thus eliminating any necessity of transferring strains between the vessels.

In another case, Fig. 3, the system is shown as applied to canal, river, harbor and lake navigation. The generation of the power is precisely similar, but in this case the electric connection between the vessels comprising the fleet is extended, so that they may proceed in single file, and the control of the propelling power of each vessel is in the hands of the helmsman or officer in charge of that vessel.

In the illustration, the power boat is shown as the last in the line, but it is, of course, apparent that it can occupy any position, and it can be readily seen that in such a fleet each vessel, within reasonable limits, possesses all the qualities of an independent vessel propelled by power, such as the avoidance of obstructions, the ability to turn sharp bends in rivers, and independently to maneuver around wharves and through locks of canals. In addition, the illustration shows the further possibility of using power generated in a central station, upon one of the boats, for refrigerating purposes on others, and it is pointed out that when such a refrigerated cargo reaches its destination, connection can be made to any source of electricity upon the shore, and refrigeration continued while the cargo is being discharged and a new one loaded.

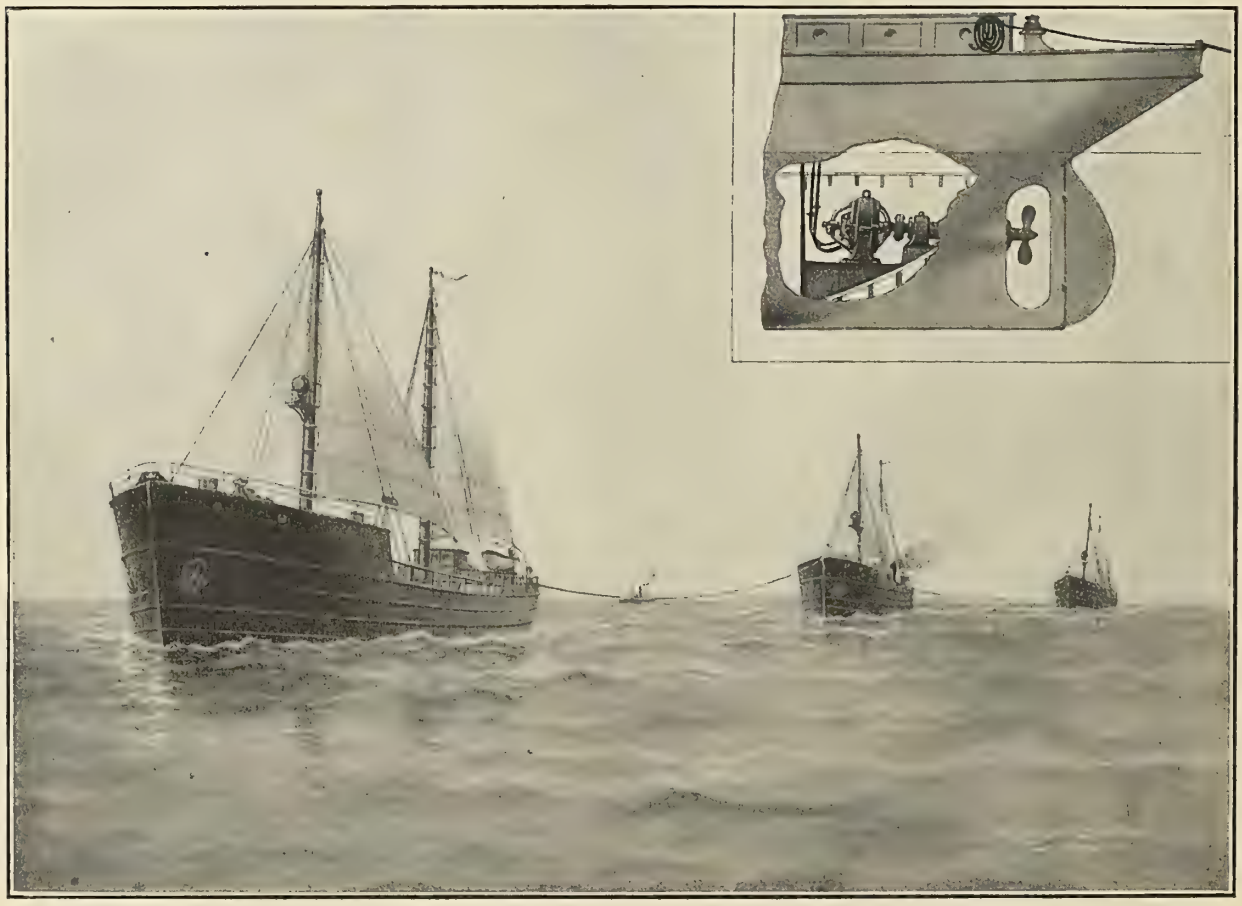


FIG. 2.—MARINE UNIT SYSTEM APPLIED TO OCEAN TRANSPORTATION.

Fig. 2 illustrates the application of this system to ocean navigation. In this illustration three vessels are shown, the central one containing the power plant, distributing power to a vessel ahead and another astern. For this class of work the power vessel would be provided with an automatic winding engine to control the length of the electric cables conveying the power to the other vessels of the fleet.

In the application of the system to the smallest class of shallow river vessels, the power is generated by an internal combustion engine using oil as fuel, and the propulsion is by means of stern wheels. With this system it is possible for

one man to care for the generating plant, and to control the movement of the three vessels comprising the fleet. The system makes possible marine transportation on a less draft than has been heretofore possible. Attention is called to the fact that the three vessels are precisely alike, and that there is no necessary structural connection of the power generating plant to the hull; so that, in case of injury or grounding, it can readily be transferred to any one of the barges.

It should further be considered that this system offers a very great additional advantage, in that it provides for a source of light without a separate installation for that purpose, the lighting circuit being, of course, taken direct from the main power circuit; and as all modern freight movement proceeds without interruption, night and day, this consideration is by

four hours per day, while with steam freight carrying vessels it is an established fact that more than half the time is spent in discharging and loading cargo; this is fully brought out in the comparison made in another part of this paper, where the resulting economy of this system is pointed out. The application of this system of navigation to the smaller rivers and waterways of the interior will result in a very great extension of the business and very many economies in operation.

At the present time such navigation is carried on by a steam propelled vessel of sufficient capacity to carry all the freight for the territory which it serves, and it is under the most severe restrictions as to the matter of draft, and consequently displacement, and at the same time must have sufficiently powerful machinery to make headway against strong

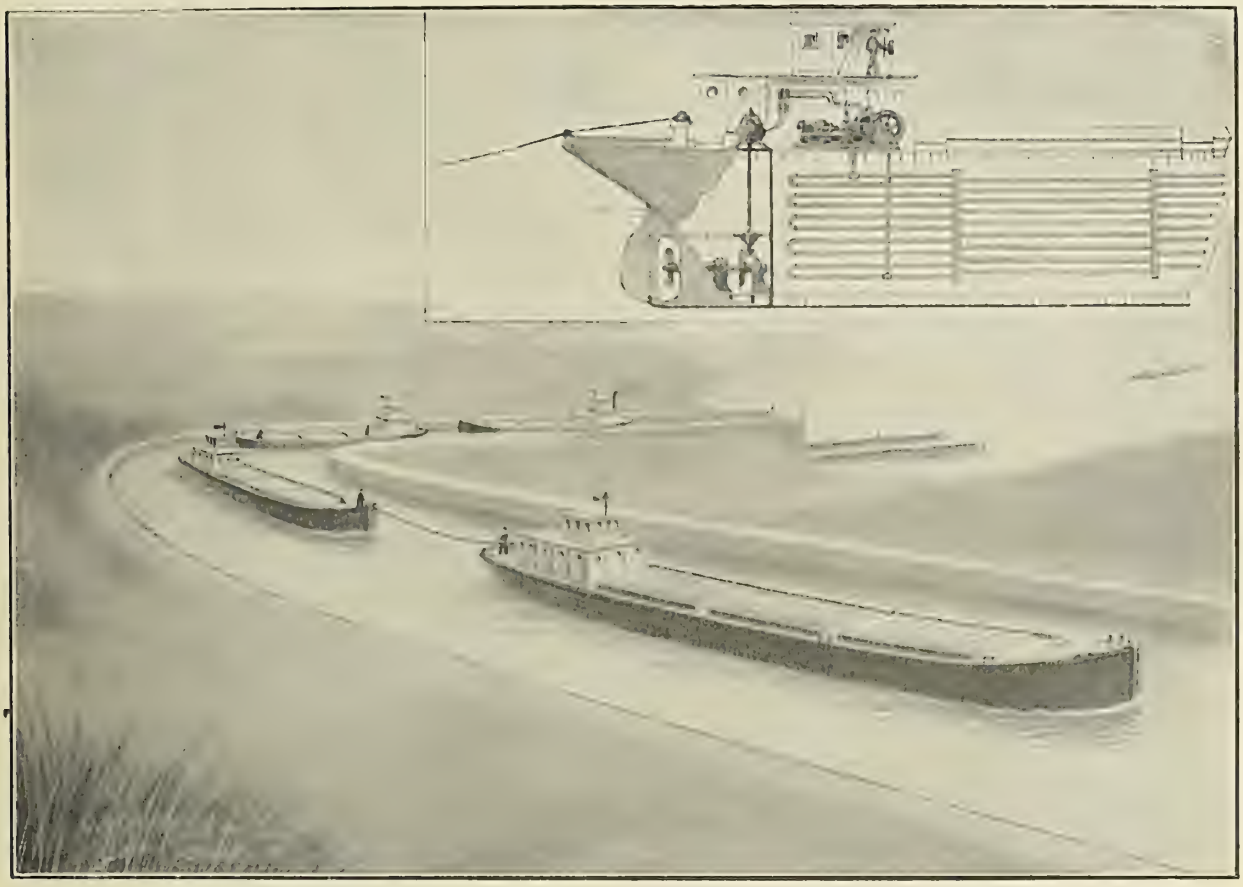


FIG. 3.—MARINE UNIT SYSTEM APPLIED TO RIVER, LAKE AND CANAL TRANSPORTATION.

no means a small one. It will be readily understood that the readiness with which electricity could be utilized for searchlights for river navigation at night would materially add to the efficiency of the system.

Further general advantages of the system are as follows: all inland water navigation is hampered and limited by the small depth of water, which limits the size of transportation units, and by limiting the amount of water on which the propelling apparatus can act, seriously restricts the application of power in large units. The electric unit system makes possible the development of power in large units, its distribution to a number of small vessels, to each of which it is applied most economically and with the smallest amount of attendance. The placing of the power plant in one vessel and the providing of the cargo space in others makes it possible to adapt each to the particular use for which it is intended, and a much higher economy in construction and operation is possible for each.

It is an established practice to operate tow-boats twenty-

currents. At every point where freight is received or discharged the vessel, with the entire crew, must remain idle while the freight is being received and discharged.

On the other hand, through the electric unit system, a power boat designed for that purpose only, capable of transmitting propelling power to a number of lightly constructed, shallow-draft barges, each equipped with sufficient electrically operated propelling power to meet the conditions, would operate as follows: Instead of the whole transportation unit remaining idle while freight was being loaded and discharged, a single barge, of a capacity sufficient for the particular freight depot, would be detached upon the up-trip at a town or city, the power boat and remainder of the fleet proceeding without delay. This procedure would be repeated at each town along the river. Upon the return trip, such barges as had been loaded would be taken up. In this way the working plant, comprising the greater part of the investment, and by far the greater part of the working force, would be kept

constantly employed and approximately twice the amount of transportation accomplished for the same investment of capital and labor as by the old method.

The collecting of perishable food products, such as are kept in cold storage, will be greatly facilitated, it being clearly recognized by all engineers that the most important factor of cold storage plants is an ample supply of cooling water, and the added fact that upon the water power can be generated cheaper than under any other conditions. When there is the additional consideration that electric power can now be purchased as readily as any other commodity, in all towns and cities, to operate the cold storage plant when the barge is detached from the power vessel, it is practically certain that this system of gathering and handling perishable food products is destined to have an exceedingly wide application.

In the broad application of this system to inland waterways it will, of course, be immediately apparent that the freight barges with their motor power are not in any way limited for their operation to any particular power vessel, but that in the extension of the system, the power vessel will be treated entirely separate from the cargo vessel, and that the cargo vessels will be moved systematically on schedule time by power vessels in precisely the same way as freight cars are moved by locomotives. But it should be pointed out that marine transportation under this system possesses several distinct advantages over the movement of freight upon railroads. The maintenance of right of way is entirely eliminated. All switching and yard work is eliminated; almost unlimited restrictions as to dimensions and carrying capacity is admissible in freight-carrying units, it being understood that any size of unit may be used with the sole provision that the amount of propelling power introduced shall be sufficient to give all the same speed when in transit.

It should also be pointed out that, when the present form of marine freight vessel or tow-boat is laid up, the whole investment is entirely useless for any other purpose; but with this system, an electric power generating vessel, when laid up for a closed season in northern latitudes, or for lack of business at any time, is still available for the generation of electricity for power or lighting. The fact that the power vessel can be laid up at a point where fuel can be stored would make it possible for such a plant to furnish electric power or lighting at a very reasonable figure.

(To be concluded.)

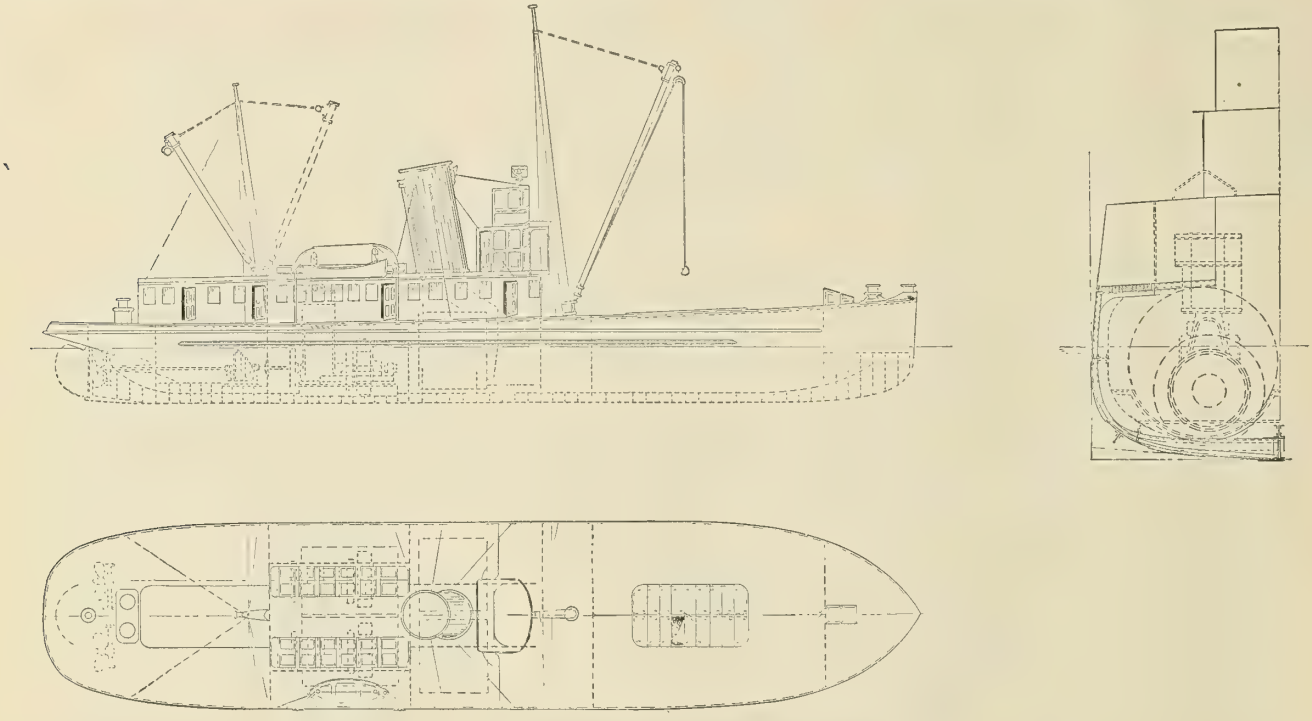


FIG. 4.—MARINE UNIT SYSTEM POWER BOAT.

THE ROYAL NAVAL COLLEGE AT GREENWICH, AND THE TRAINING OF ENGINEER OFFICERS FOR THE ROYAL NAVY.

BY J. W. W. WAGHORN, D. SC.

Few more imposing buildings are to be seen in Great Britain than the noble pile designed and built by Sir Christopher Wren as a home for disabled seamen, and now used as the principal center for imparting technical knowledge to the officers of the various branches of the royal navy. Probably still fewer places are as deeply steeped in historic reminiscences of the Plantagenet, Tudor and Stuart monarchs, or have been more closely associated with the varied fortunes of those houses. The present buildings occupy the site of an earlier building built or enlarged by Duke Humphrey, of Gloucester, the brother of Henry V.

Some idea of these older buildings enlarged by successive monarchs can be obtained from the copies of old prints, which show how they appeared in the times of Elizabeth and of Charles II. The print of 1662 shows also the castle on the rising ground of Greenwich Park close to Blackheath, also built by the "Good Duke," and used as a sort of sanatorium for sufferers from the damper air of the lower ground by the river. The castle was given over for astronomical observations by Charles II, and has been ever since the royal observatory and residence of the astronomer royal from the times of Flamstreet, the first holder of the office. This is also shown in the view of the college grounds and buildings, looking from north to south.

Charles II, some four years after his restoration, commenced to rebuild the palace under the direction of Sir Isaac Denham, who took down the old buildings, of which at the present time no trace remains except the crypt below the block containing the naval museum. After the victory of Cape La Hogue, which shattered the hopes of James II of regaining his

GENERAL VIEW OF THE NAVAL COLLEGE FROM THE RIVER. THE OBSERVATORY IN MIDDLE BACKGROUND.
(Photographs by E. J. Collins, R. N. C.)

lost kingdom, Mary (in William III's absence), in gratitude to her naval heroes, decided that the partially rebuilt palace should be devoted as a home for seamen "disabled by age, wounds or accidents." Wren furnished the designs and lived close by during the completion, and William, after Mary's death, pushed forward the work of rebuilding. Between 2,000 and 3,000 pensioners resided at the hospital at one time, but in later years the number was reduced to about one-half; the men themselves disliked the disciplinary character of the life, and preferred a pension with the freedom of their own homes.

In 1873 the government, in which Goschen was the first

FUNERAL OF QUEEN ELIZABETH AT GREENWICH IN 1603.

Lord of the Admiralty, decided that it would not be inconsistent with the traditions of its past to convert the hospital into a college for the scientific training of all branches of the royal navy. For fourteen years before the establishment of this college an advanced course of instruction in mathematics and technical subjects was held at the Royal School of Naval Architecture and Marine Engineering in some buildings of the South Kensington Museum, attended by a few students of naval architecture and naval engineer students selected annually by examination from those training at the royal dockyards. The course lasted for four years, on what is now known as the "Sandwich" system, about seven months of every year being spent in theoretical study in London, and five months in practical work at the dockyards. The school owed its initiation to the urgent representation of a small committee of the Institution of Naval Architects, of which Scott Russell,, the designer of the *Great Eastern,* was an active member, who felt strongly the necessity of an advanced training for engineers and shipbuilders in the interests of the

IN 1662, SHOWING HILL ON WHICH OBSERVATORY IS NOW LOCATED.

country génerally, and the Admiralty more particularly. The school was dissolved, and its work transferred to Greenwich on the establishment of the Naval College. That the former school fulfilled the purpose for which it was founded is shown by the fact that nearly all the high technical posts at the Admiralty, and very many at Lloyd's and at the great engineering and shipbuilding firms of the country, are filled by its former pupils.

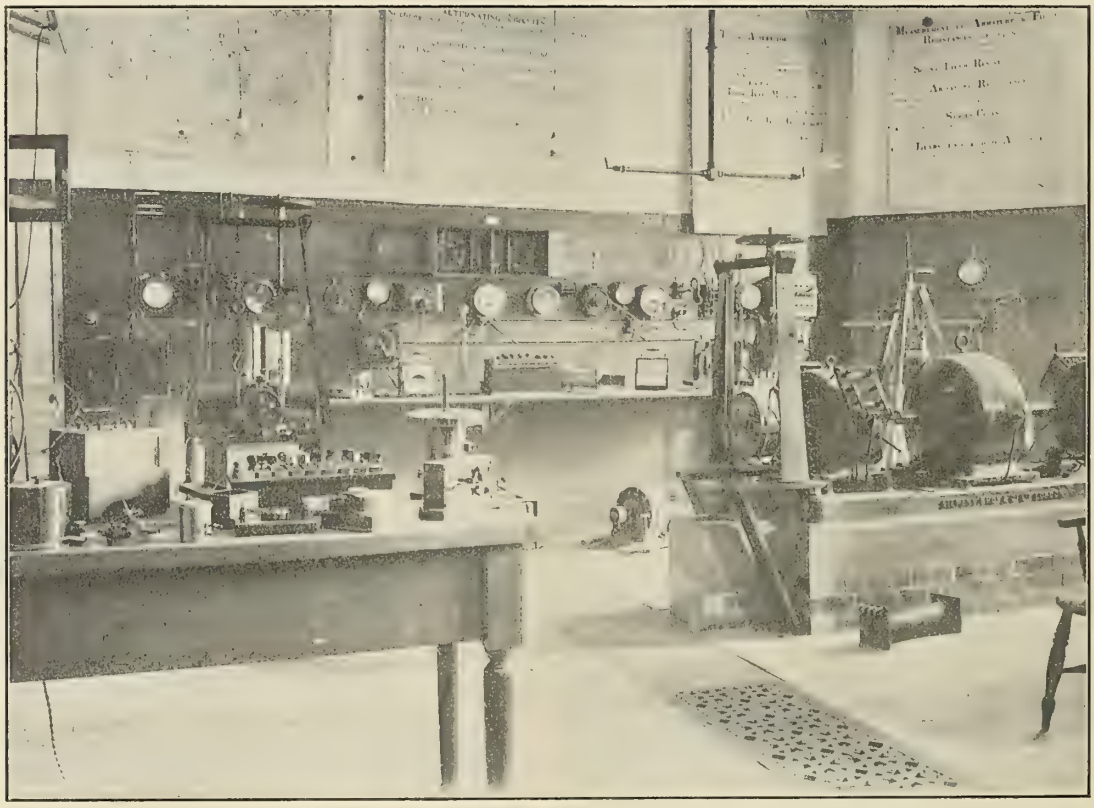
THE BUILDINGS IN 1662.

At the time when the hospital was converted from its earlier

purpose as a home for pensioned seamen it had become gradually recognized that technical scientific education was required, not only for the engineer officers and the future constructors at the dockyards and designers at the Almiralty, but also for all the executive officers of the navy. In the previous days of the old sailing vessels and wooden men-of-war, a knowledge of navigation was the only scientific attainment expected of the naval officers; presence of mind, courage, coolness, readiness of resource and the facility of command sufficed for the rest. When we remember that Columbus, with no appliances beyond the imperfect form of quadrant, known as the astrolabe, and a compass of which even the fact that its setting varied largely at different places was not common knowledge, doubtfully known to himself, with no chronometer, log or chart, was able by dead reckoning, which meant guessing the speed through the water, in each of his voyages from the West Indies, to make his port in Spain with certainty, and to predict at night that a certain land would be sighted in the morning, it is not to be wondered at that a limited mathematical knowledge, with the help of modern appliances, sufficed for the needs of the navy up to comparatively recent times.

During the last half century, however, the modern man-of-war has rapidly become, and with an ever-increasing acceleration, a collection of mechanism of the most complex type; and the executive officer, especially if he undertakes at some time in his career the duties of a gunnery or torpedo lieutenant, must acquire a knowledge (and know a good deal) of the practical side of more than one profession. The naval officer should be proficient in the working parts, and understand the details, of the numerous and complicated items of machinery, hydraulic, pneumatic and electric, required for the working of guns, torpedoes, mines, for transmitting orders automatically to all parts of the ship, and varying from the powerful machinery required for a 12-inch gun to the delicate optical adjustments of a rangefinder. He should know something of the working of his main and auxiliary engines, and have at least an elementary knowledge of naval construction; but included directly in the duties of the executive staff are the motors, dynamos, lamps, searchlights, telephone exchanges and wireless instruments, which make the modern battleship or first class cruiser an electric engineering station of considerable complexity and no mean magnitude.

He should possess the necessary mathematical and technical knowledge required for navigation and pilotage, and understand the troublesome subject of compass errors and their correction, complicated not only by the constant alteration due to a change of geographical position, but also by the varying disturbances due to the close proximity of dynamos, motors and other magnetized masses. Looking at the duties from other points of view, he should be a good linguist, something of a lawyer, acquainted at least with the laws of evidence and practice of courts martial, and be able to cope with the difficult problems of maritime and international law. He should be an expert in naval strategy and tactics, and know something of the duties of the sister service, when in charge of expeditions on shore.



A CORNER OF THE DYNAMO ROOM IN THE ENGINEERING LABORATORY.

When, at the time the Greenwich College was started, the need of a much more extended system of education for the naval officers was felt, arrangements were made by which all executive officers, after they had spent some time at sea and had attained the rank of sub-lieutenant, should compulsorily be appointed to the college for a course of study lasting about six months, and terminated by a qualifying examination. Officers of higher rank, lieutenants, commanders and captains, were encouraged, at periods when not appointed to a commissioned ship, to attend classes in various subjects, such as mathematics, physics, steam, chemistry, languages, fortification, naval strategy, etc. Lieutenants qualifying for gunnery or torpedo duties spent the session of nine months at Greenwich before proceeding to the special training ships for the practical part of their instruction. A war course for senior officers (captains and commanders) was held for several years,

and even a short course for admirals, lasting for six weeks at a time and always well attended, showed that the modern naval officer recognized that at no period of his service was he too old to learn. During the last few years, however, much of the instruction previously given at Greenwich has been transferred to the naval ports. The war courses are held at Devonport, Portsmouth and Chatham, the qualifying courses for the special technical officers (gunnery and torpedo) are held at Portsmouth, and only those who show special ability (about one-third of the number qualifying) proceed afterwards to Greenwich for a more advanced course of nine months' duration.

On the same principle, only those sub-lieutenants (about one-half the total number) who attain a sufficient standard in an examination held at sea, proceed to Greenwich for a further course of six months' instruction. Also, whereas formerly all the engineer officers, after their training at Keyham, came to the naval college for one session, under the present regulation only those most likely to profit by the instruction are appointed. The result of these two conclusions, that where possible naval subjects should be taught in the ports where the fleets assemble, and that only those who have shown particular aptitude should proceed to more advanced education, has resulted in a considerable diminution of the students in residence, who number normally under the present regulations about 100, as compared with almost double this number a few years ago.

THE COLLEGE GROUNDS, PAINTED HALL AND CHAPEL.

In addition to executive officers, engineering officers and students of naval architecture, all marine officers, both of the Royal Artillery and of the Light Infantry, are attached to the college for a period of one or two years. Gentlemen, graduates of the universities, qualifying for the rank of naval instructor, attend the courses, and many individual officers are appointed for work in some particular department before taking up some technical appointment or undertaking some special work.

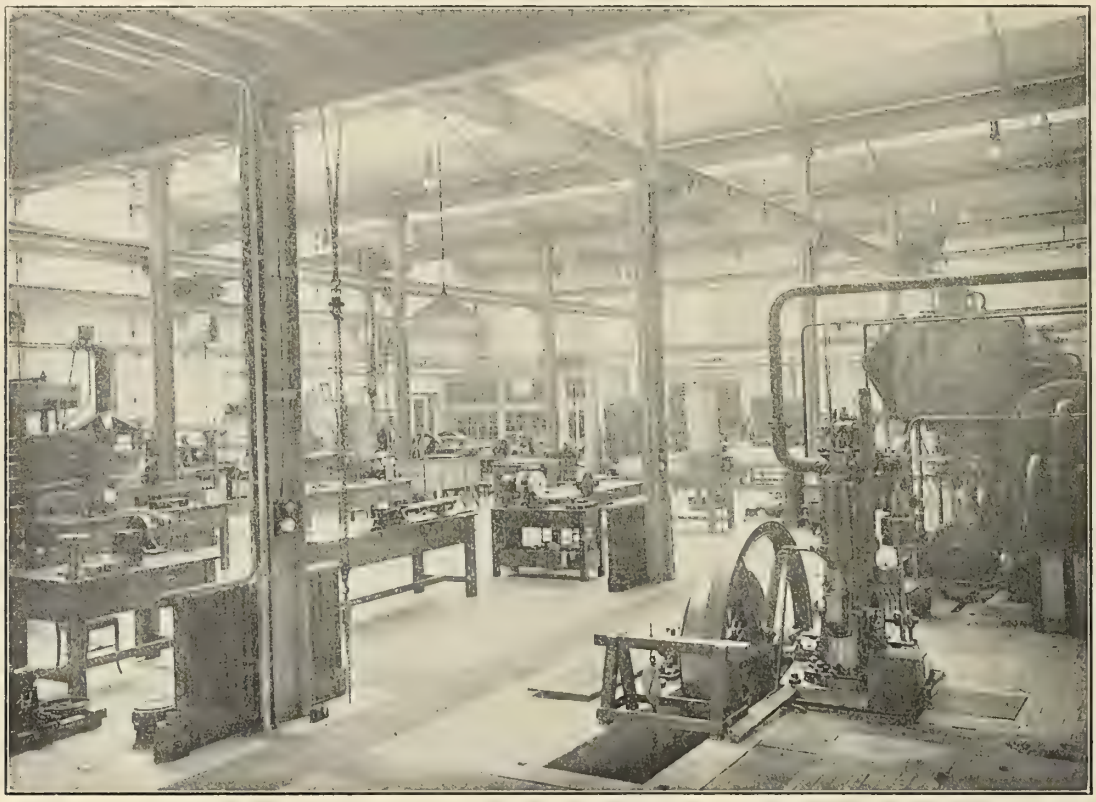
Candidates who have obtained nominations for the engineering cadetships, of limits of age between 14½ and 16½, are examined annually, and those selected proceed to Keyham for a course of training. It must be remembered, however, that the terms used refer to the past, and that the system that has produced the present officers of the engineering branch is now superseded by the new scheme of a common entry and joint training up to a certain point in their career, for the executive, marine and engineering officers. The education and details of courses referred to in this article apply obviously to the older system, which will soon be obsolete.

The successful probationary cadets pay £75 ($365) a year towards the expenses of their residences and training at the Engineering College at Keyham, but scholarships are awarded to a considerable number at the head of the list, which reduces the fees to £40 ($195) a year. Such students, engineering cadets, must enter the government service if they are offered commissions at the end of their course of four years. The remainder, probationary cadets, will be allowed to take the commissions, if they are successful in the final examinations, but are not obliged to do so. About one-half of the total entry receive commissions at the end of the course. The training is partly mathematical and scientific, under a staff of which Prof. Worthington, F. R. S., is the head; partly practical and technical, under a staff of engineer lieutenants, one in charge of each term, and an engineer commander, all the organization and general supervision being carried out by an engineer captain; an executive officer of the rank of captain being at the head of the whole establishment.

Two mornings and three evenings in a week are devoted to the mathematical and scientific studies. The rest of the time is spent in the various workshops, iron and brass foundries and in repairs on board ship. A separate fitting shop and a drawing office are allotted to the students. Their work is carried on under the supervision of the engineer lieutenants, assisted by workmen instructors. Whenever it is possible, the whole of the repairs of a certain ship are carried out by the cadets, under the same conditions as by the factory workmen, and the trials run under the usual tests.

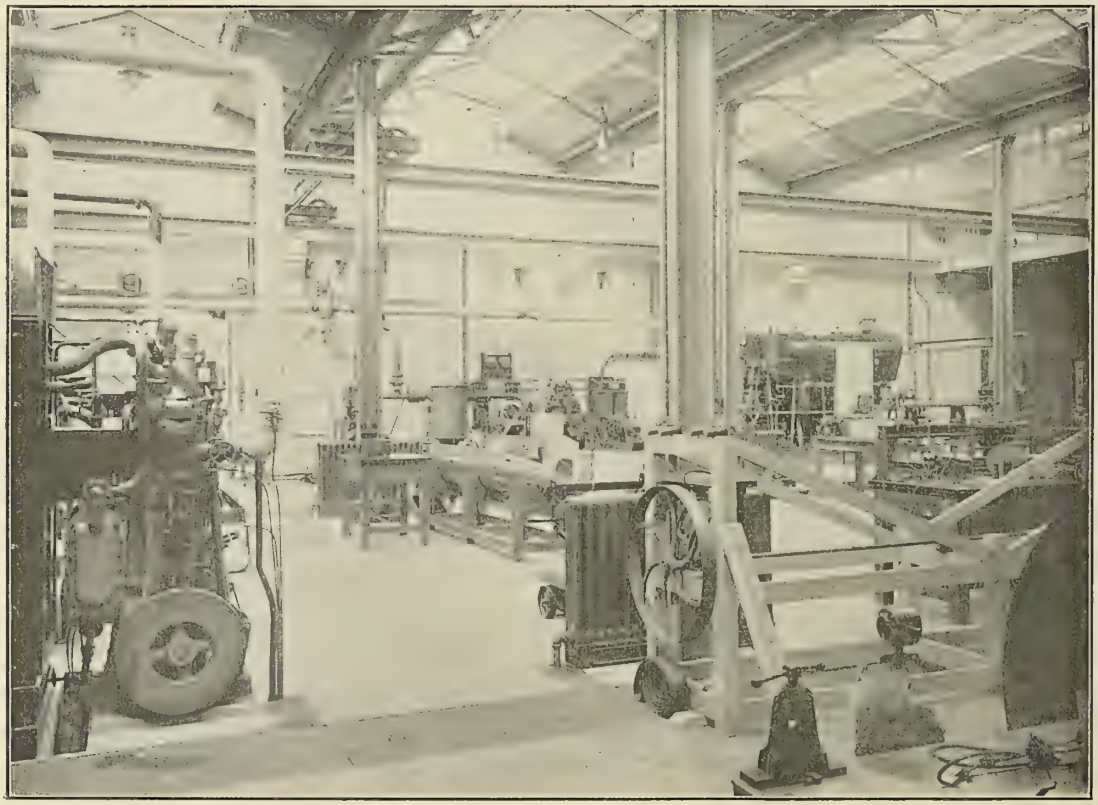
A certain number, generally about one-half of those who obtain commissions, proceed to Greenwich for a course of nine months' further study. At the end of their second year at Keyham, appointments are offered to the first two or three on the examination list to enter the royal corps of naval constructors. The training in their case naturally differs somewhat on the technical side from that of the engineering cadets; they also proceed to Greenwich, and stay there for the full advanced course of three years.

The instruction at Keyham includes algebra, trigonometry, differential and integral calculus, the application of graphical methods to the solution of problems, statics, dynamics and



A VIEW IN THE MECHANICAL LABORATORY.

hydrostatics; mechanical drawing, mechanism and applied mechanics, and strength of materials, with laboratory work in these subjects; lectures and laboratory work in chemistry, including analysis of funnel gases, hardness of water, boiler incrustation, etc.; lectures and laboratory in physics, including optics, heat and the elements of thermodynamics, electricity and magnetism, the applications of electricity in dynamos, motors, wireless telegraphy, etc. The engineering lectures include the description of the parts of various types of steam engines and boilers, properties of steam, indicator diagrams,

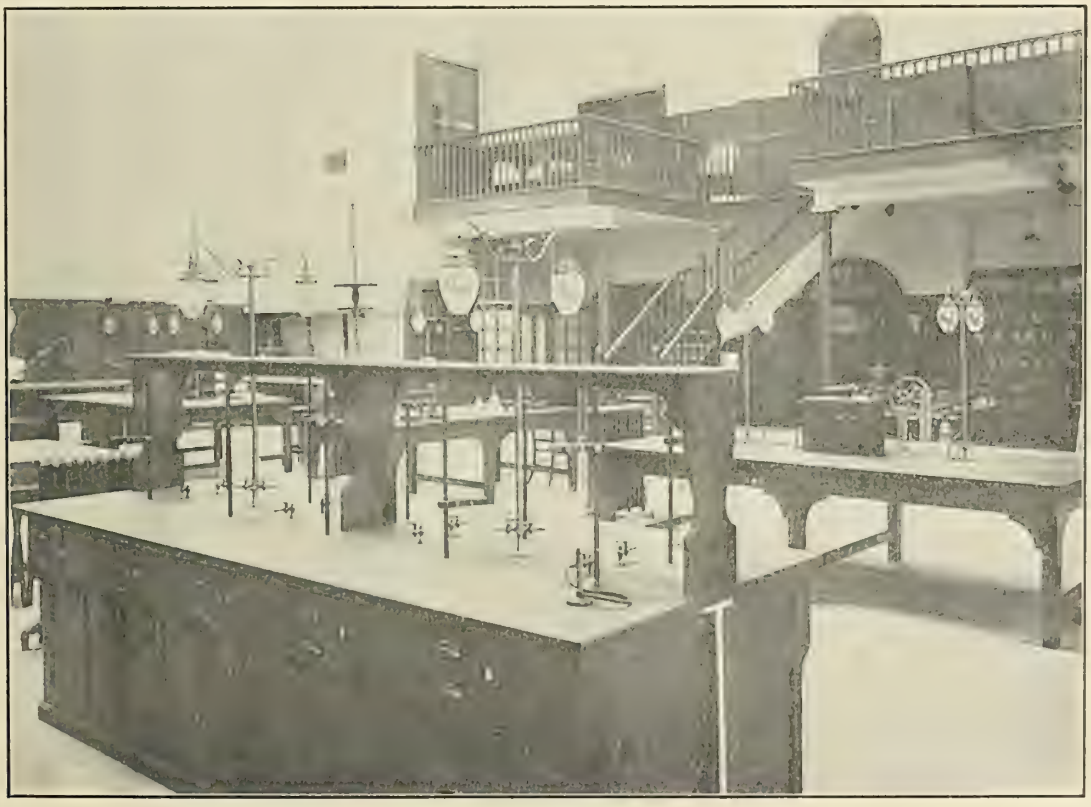


A SECTION OF THE MECHANICAL LABORATORY.

THE APPARATUS IN THE PHYSICAL LABORATORY.

combustion, oil and gas engines, engine room duties, propulsion of ships, hydraulic machinery and the metallurgy of iron and steel and alloys used in naval practice.

A certain number of appointments to the rank of engineer sub-lieutenant have, under the regulations in force up to the present time, been offered to candidates, not trained at Keyham, between the ages of 20 and 23, who have had at least one year's training at a recognized technical institution, not less than three years at some approved engineering firm, and who obtain the requisite qualifying marks in the papers at the final examination to the Keyham cadets. If their examination record is sufficiently good, they can proceed to the advanced



THE NEW CHEMICAL LABORATORY.

course at Greenwich. At the termination of the session's work, a few of the engineer sub-lieutenants, generally about four in number, are selected to stay for a further course of two more sessions (of nine months each) with the view of qualifying for the more important posts at the Admiralty and royal dockyards; all the students of naval construction also stay for the full course of three sessions.

Private students of either marine engineering or naval construction may be admitted to the full advanced courses on passing a qualifying examination and payment of an annual fee of £30 ($146). These students do not,however, reside at the college. Scholarships and free studentships are offered to those private students who attain a certain standard at the entrance examination, and such students may be taken into the Admiralty service at the completion of their studies, competing on equal terms with the students trained in the government establishments. Testimony to the high value of the Greenwich instruction is given by the fact that many foreign governments have, since the first institution of the college, been glad to send the ablest students of their engineering and construction corps, and executive and engineer officers of their respective navies, to join these classes. As long as it was permitted by our Admiralty, the American, Italian, Danish, Swedish, Chinese and Japanese and other governments sent some of their ablest men, and the high offices of the naval construction and engineering departments of the nations were filled mainly with former students of Greenwich. Of recent years, the Admiralty has been less ready to supply the technical training for other countries, but the Japanese have already been allowed to send two or more representative officers, and these men, as we might expect from the known ability and devotion to study of their race, always take good positions in the final examinations, and hold their own, in spite of the difficulties due to their imperfect knowledge of the language, with the best of our own men. At the present time, one Portuguese naval officer, two Japanese students (of naval construction and of marine engineering, respectively) and a Japanese commander who took an active part in the last war, are at the college, and in the ensuing session several Chinese students will be admitted.

The mathematical work of the first year repeats and treats more fully the subjects already taken up at Keyham, algebra, trigonometry, co-ordinate geometry, differential and integral calculus and the mechanics of solids and fluids. In the second and third years the course in pure mathematics includes analytical solid geometry, elementary differential equations, mainly in applications to mechanical and physical problems, curve plotting, etc. In applied mathematics, the mechanics of solids and fluids is treated in much greater detail and by more general methods than in the first year course. Besides the usual problems of statics and dynamics of a particle, are considered the equilibrium of chains and elastic beams, and the general dynamics and kinematics of rigid bodies, special attention being paid to questions involving rotation, gyrostatic control, etc. The naval constructors have also a course in dynamics.

In applied mechanics the first year syllabus for the students is on the same lines and general scope as the final B. Sc. or B. E. at any of the universities. In the second and third years, the work may be compared with a post-graduate course in the higher branches of applied mechanics in relation to design, such as secondary balancing of engines, vibration of structures, whirling of shafts, etc. Thermodynamics of the steam engine and steam turbine, of internal combustion engines, of refrigeration and air compressors, design of centrifugal pumps, of turbines and other hydraulic plant, are taken up; with lectures on stream lines and wave motion and resistance and propulsion of ships.

An important feature of the instruction of this department is the course of practical work in the newly equipped laboratory, of which two views are given. Experiments are carried out in the first year illustrating the efficiency of lifting tackle, the laws of linear, angular and harmonic motion, illustrated by the usual apparatus, such as the ballistic pendulum, the gyroscope, etc.; the laws of friction, the measurement of elastic constants of materials, the discharge through orifices, etc.

In the last two years the extended course includes the testing and microscopic examination of metals and efficiency tests of various types of boilers and engines (steam, hydraulic and internal combustion). In the third year research work in various subjects is undertaken, in which the students are expected to use their own powers of resource and originality. During the last term investigations have been carried out on the efficiency of injectors, of petrol engines, on lubricants, on the application of Hele Shaw's stream line apparatus for the estimation of mechanical stresses in structures, on the hardness and ultimate strength of iron-carbon alloys, on the mechanical properties of materials, coupled with microscopical examination and chemical analysis.

The plant includes, among other items, a marine engine of 50 horsepower by Belliss & Morcom, coupled to a Siemens shunt dynamo; a 33-kilowatt Parsons turbine and direct-current generator, and a 20-kilowatt De Laval turbine and generator. The internal combustion engines include a 15-horsepower Diesel, 12-horsepower Thornycroft petrol, 12-horsepower Crossley gas and 2½-horsepower Hornsby-Ackroyd hydraulic. A 100-ton hydraulic testing machine by Rushton; an air refrigerating machine and air compressors; an equipment by Zeiss for the microscopic examination of metals, and a dark room for photographic work are also provided. The building is lighted and supplied with alternating current from the mains of the South Metropolitan Company, and a battery of 55 storage cells enables direct current to be obtained, when required. A well-equipped work shop, with lathes, shaping and milling machines, serves for the construction of new appliances and the repairs necessary for those existing.

A very considerable proportion of the working hours of the engineer sub-lieutenants is devoted to the design and drawing of engines and their component parts. Lectures and notes on the parts designed are given by an engineer officer on the Admiralty staff, assisted by an engineer officer attached to the college. About six hours a week are given in the first year to this subject, which enables the student to complete about ten finished drawings, with calculated dimensions of parts, such as the crankshaft, piston, piston rod and crosshead, etc., suitable for the engines of a given ship.

In the second and third years about ten hours a week are devoted to this subject, during which time a complete design in full detail of a set of main engines for a given ship is worked out. Two students work together, and complete about twenty drawings, including the general plan and elevation of main and auxiliary engines, details of parts, and arrangement of pipes in boiler and engine room. Lectures on naval architecture are given by a member of the corps of naval constructors, and lectures on points of present interest in naval practice, such as oil fuel, turbines and internal combustion engines, by an engineer commander attached to the college and in charge of the instruction to executive officers in steam, mechanism and machine drawing.

The first year students attend lectures on the application of electricity, in continuation of their previous courses at Keyham, including the principles and service details of arc lamps, searchlights and glow lamps, of continuous-current dynamos and motors, of alternating-current circuits and their properties, of the various types of alternating-current dynamos and motors and their characteristic properties, transformers, rectifiers, etc., on the transmission of power, and the principles and

apparatus involved in wireless telegraphy. These lectures are supplemented by practical work in the physical laboratory, including efficiency tests of the various types of dynamos and motors, transformers, lamps, rectifiers, etc., the determination of the magnetic constants of materials, of capacities and inductances, etc.

The plant includes a 12-kilowatt motor-generator set by Siemens, shown in the view of one corner of one of the dynamo rooms, consisting of a shunt-wound motor coupled on either side to a direct-current compound dynamo. These dynamos can be uncoupled from the motor and driven as shunt, series, cumulative or differential motors from the direct-current mains. The machines are fitted with slip rings connected to the armature, and will consequently generate three-phase current, either as dynamos or motors. They can be driven as rotary converters, either from the direct or alternating side, and can be used as synchronous motors. The plant is also conveniently arranged for efficiency tests on the usual Hopkinson method. Another motor-generator set by Crompton consists of a two-phase induction motor driving on one side a continuous current dynamo and on the other a two-phase generator, which can also be run as a single-phase or two-phase synchronous motor. A motor generator set by Schuckert provides continuous current from the alternating mains of the South Metropolitan Company. Among other items are a four-pole and a two-pole compound dynamo by Siemens; a small alternating generator and separate exciter by Johnson & Phillips, and two and three-phase induction motors from 12 to 2 horsepower by the same firm. Rooms are fitted up for the testing of arc and glow lamps; for the measurement of inductances; for calibration of instruments by Crompton's potentiometer, for the use of wave meters in wireless experiments; for observations in terrestrial magnetism; for compass correction; for work in heat and light, and for a course of elementary mechanics and hydrostatics. Another view shows a portion of the large room used for ordinary electrical measurements, with Wheatstone bridges, etc. A dark room and thoroughly equipped photographic studio is also attached to the department.

The lectures in chemistry deal, besides the general principles, with such practical applications as fuels, boiler incrustations, etc. A course of lectures on metallurgy is also given in this department. In the first year, the practical work is mainly qualitative analysis; in the second year, on the testing of coal, liquid and gaseous fuels and their analysis, physical and chemical examination of lubricating oils, examination of water for use in boilers, etc. A view of a portion of a large room recently added to the chemical laboratory is shown.

Instruction in languages, French and German, is given to those taking the long course. All officers are requested to spend a certain time every week in the exercises of the Swedish physical drill. The recreations in the college life have not been neglected; there are two racquet courts, many lawn tennis courts, a fine bowling alley and a billiard room. The lease of a football and cricket ground a little distance from the college ground will, unfortunately, terminate this year, and pass into the hands of the speculative builder.

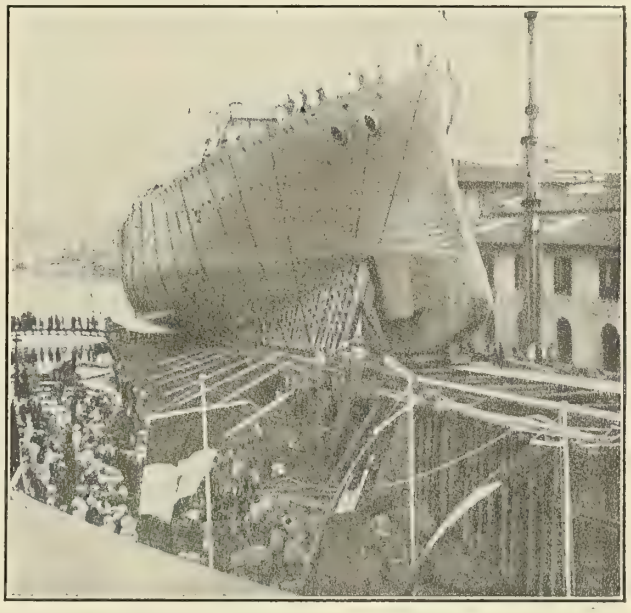
The courses of study, and all the educational arrangements, are under the control of the director of naval education, Professor I. A. Ewing, F. R. S., who is also responsible for all the other educational establishments connected with the Admiralty, and for all matters pertaining to the training of the personnel of the navy. An "admiral president" is at the head of the college, and is assisted in all matters of discipline by a naval captain. It must, of course, be borne in mind that the education and training of the engineer officer as shown in this sketch refers to the present and the past, but that in a very short time a new system will take its place, of which the general scheme, but not the details, are yet public.

Italian Armored Cruiser Pisa.

On Sept. 15 there was successfully launched from the shipyard of Orlando Brothers & Company, Livorno, Italy, the first of four first-class armored cruisers building for the Italian navy. The ship has the following dimensions:

	Meters.	Feet.
Length over all	140.5	461
Length between perpendiculars	130.	427
Extreme beam	21.06	69
Depth	12.15	39.9
Mean draft	7.18	23.6
Maximum draft	7.43	24.4
Metacentric height	1.2	3.94

Normal displacement in tons, 10,118.



LAUNCHING OF THE ITALIAN ARMORED CRUISER PISA.

This ship is propelled by twin screws actuated by triple expansion engines, with a designed horsepower of 19,000 under forced draft, and at 132 revolutions per minute. This is expected to give a speed of 22.5 knots, with a corresponding speed of 20 knots at 15,200 horsepower and natural draft. Steam is supplied by twenty-two watertube boilers of the Belleville type, fitted with economizers.

There is a complete armor belt running from stem to stern, with a width of 7 feet 3 inches, of which 4 feet 11 inches is below the waterline. The maximum thickness is 7.87 inches, decreased to 3.16 inches at stem and stern. The protective deck has a thickness of 1 inch.

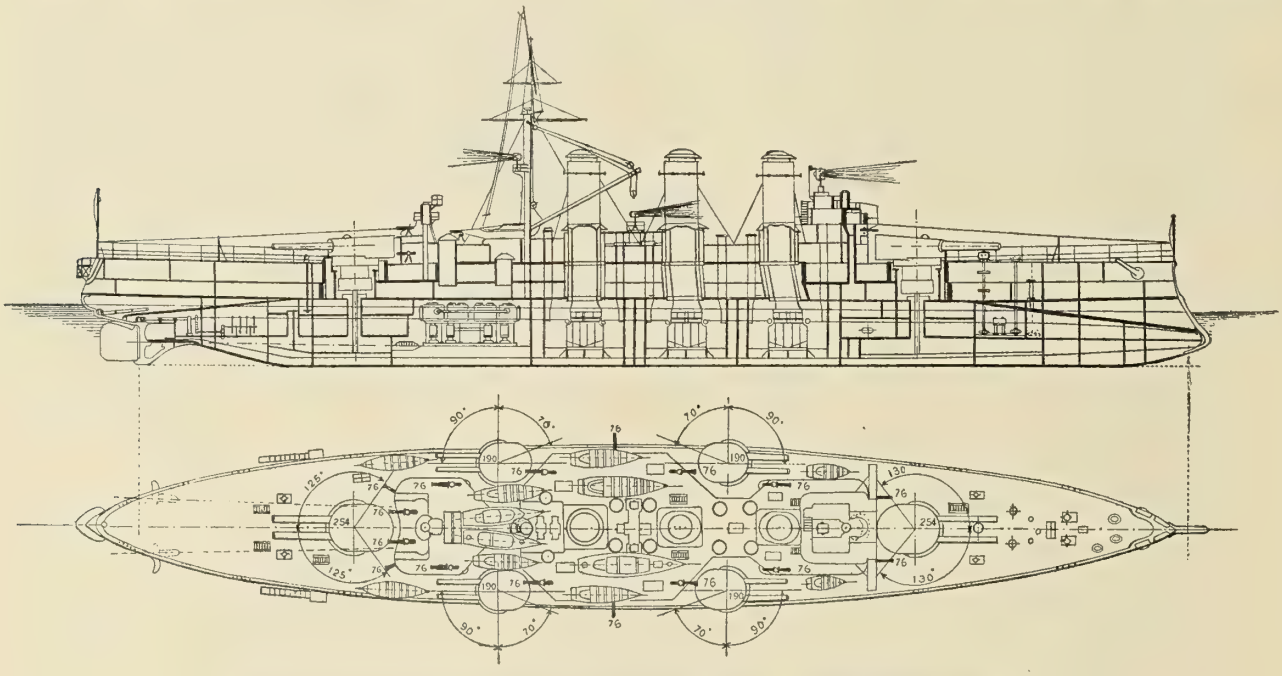
The battery is an extremely powerful one, including four 10-inch guns, 45 calibers long, mounted in pairs in turrets forward and aft, with an arc of fire of 260 degrees, half each side of the center line. The height of these muzzles above the water plane is 24 feet 3 inches. There are eight 7.5-inch guns, 45 calibers long, in pairs in four turrets at the corners of the superstructure. These have an altitude above the water of 22 feet 2 inches. They have a range of fire of 160 degrees, of which 90 degrees comprehends the arc between the fore-and-aft line and the beam for the various guns. The secondary battery includes sixteen 3-inch guns, eight 3-pounders and four Maxims. There are three 18-inch torpedo tubes, all submerged, two being located just aft of the ram, while the other one is just above the rudder. All of the artillery is of the latest Vickers type, and was made in Barrow-in-Furness.

These ships are such an advance over anything else of the

	Pisa.	*Charleston.*	*Cornwall.*	*Tokiwa.*	*Marseillaise.*
Displacement in tons	10,118	9,700	9,800	9,750	9,856
Horsepower	19,000	27,200	22,700	20,550	21,800
Speed in knots	22.5	22.04	23.69	23.09	21.64
Admiralty constant	281	179	268	274	214
Main battery	Four 10″ Eight 7.5″	Fourteen 6″	Fourteen 6″	Four 8″ Fourteen 6″	Two 7.6″ Eight 6.4″ Six 3.9″
Broadside in pounds	2,800	800	900	1,700	822

same size and type yet laid down that a comparison with some of the efforts of other powers will doubtless be interesting. With this idea in view we will compare them with the *Charleston* class of the United States navy, the *Cornwall* class of the British navy, the *Tokiwa* class of the Japanese navy, and the *Marseillaise* class of the French navy. These ships are all near enough of a size to make a comparison worth while.

The splendid propulsive results achieved with the *Cornwall* and *Tokiwa* will in all probability be equaled or surpassed by the *Pisa,* such is the extremely high character of Italian design from this point of view. In comparison, the *Charleston's* performance is truly pitiable, and her broadside is the weakest of the five, being less than 30 percent as powerful as that of the *Pisa,* and at long ranges much less even than that small percentage.



INBOARD PROFILE AND BATTERY PLAN OF THE NEW ITALIAN ARMORED CRUISER PISA.

The aggregate tonnage of vessels going alongside the wharves in Hamburg harbor, Germany, during 1906 amounted to some 6,000,000 tons net. Of these vessels 2,551, an aggregate of 3,900,000 tons, carried the German flag, showing a notable increase as compared with the previous year. As for England, there was a slight decline in tonnage, compared with 1905, the figures being respectively 1,520,000 tons and 1,580,000 tons, while the number of vessels was about the same—2,056 and 2,054. Norway accounts for 296 vessels with 159,000 tons, Holland has 281 vessels with 158,000 tons, which means an increase of some 50 percent. Denmark comes next with 321 vessels and 93,000 tons; and then France with 84 vessels and 75,000 tons—about the same as the previous year. Sweden shows a slight decline, with 124 vessels and 60,000 tons. Of other countries, Spain accounts for 20,000 tons; then come Italy with 12,000 tons, Russia with 6,000 tons, and Austria-Hungary, with one solitary vessel of 3,000 tons. The United States of America was not represented at all.

A New 150-Ton Hydraulic Crane.

The crane has been erected for the Elswick Ordnance Works of Sir W. G. Armstrong, Whitworth & Company, Limited, and is of the fixed luffing type. All the motions, rotating, hoisting, and raising the jib, are performed by hydraulic power. The crane is intended for handling guns and their mountings, and for general use in completing large warships. Owing to the increasing size and breadth of modern vessels, the shear legs hitherto used for this purpose have not sufficient reach over the water.

The crane is capable, when working with an effective pressure of 750 pounds per square inch, of lifting a load of 150 tons from 15 feet below to 85 feet above quay level, or through a total height of 100 feet. The maximum rake or radius with this load is 99 feet, and the minimum rake 44 feet, the maximum outreach beyond the face of the quay being 74 feet. Auxiliary lifting machinery is fitted for dealing with lifts up to 25 tons, the maximum rake for this lift being 117 feet and the minimum rake 50 feet. The range in turning is unlimited.

The pedestal is constructed of steel plates and angles, and has an archway through it of such size as to allow of two lines of rails being laid through it. It measures 38 by 45 feet across the corners. The pedestal is bolted to the foundations by 24 wrought iron holding down bolts, six at each corner. The revolving portion of the crane is carried on the top of the pedestal, and turns on a ring of steel "live" rollers

working between roller paths of cast steel, a steel central pivot being also fitted. The external diameter of the roller path is about 38 feet. The pillar, framing and jib are of steel plates and angles strongly braced together.

The main lifting machinery is in two sets, each set being capable of lifting 75 tons, stop valves being provided so that each set can be worked independently, or in conjunction with the other set. Both are contained in the pillar, and each consists of two hydraulic cylinders with rams acting on a common crosshead fitted with multiplying gear (8 to 1), guides and steel wire lifting rope 7 inches in circumference with a breaking strength of about 160 tons. Each rope is doubled over an equalizing sheave near the jib head, and led over the sheaves in the purchase blocks; thence by conveyance and the multiplying sheaves to fast ends on the cylinders, the arrangement being such that the 75-ton load on each of the two purchase blocks is taken on four parts of the rope. The purchase blocks are counterweighted so as to act as overhauling weights, and the shackles are fitted with swiveling arrangement.

The auxiliary lifting machinery is contained in a steel framing secured to the front of the main pillar, and consists of a hydraulic cylinder and ram fitted with multiplying gear (4 to 1), guides, conveyance sheaves and steel wire rope 7 inches in circumference, with a breaking strength of about 160 tons, the rope being led over a sheave on the jib head, and fitted with a swivel hook and an overhauling weight.

The luffing machinery is placed on an inclined frame at the back of the pillar, and is of the direct-acting type, there being two hydraulic cylinders, the plungers of which working downwards act together on a forged steel crosshead, to the ends of which are attached the back ends of the steel luffing stays, the outer ends being attached to the jib head, so that the motion downwards or upwards of the crosshead luffs the jib in and out, respectively. The crosshead works on forged steel guide plates bolted to the inclined luffing frame, the guide pieces on the crosshead being fitted with gunmetal faces. An overhauling cylinder for assisting in luffing out the jib when unloaded is placed between the luffing cylinders, being fitted with ram, guides, multiplying gear (2 to 1) and two 1 5/16-inch overhauling chains acting on the luffing crossheads. This cylinder is always open to the hydraulic pressure when the crane is at work.

GENERAL VIEW OF THE NEW ELSWICK CRANE HANDLING A 12-INCH TURRET.

The crane is turned by a hydraulic motor of the oscillating-cylinder pattern, having three cylinders and rams, and actuating, through spur and bevel gear, two forged steel pinions engaging with the turning rack, which is bolted to the top of the pedestal. The turning machinery has two changes of gear, so that the power and speed in turning can be varied to suit the load being dealt with, clutches being provided for putting either set of gear in or out of action. A brake is fitted on the turning gear. The valves for controlling the

lifting, luffing and turning motions are fixed on the floor of the revolving platform in a house which also contains the turning motor and gearing. The levers for actuating the valves are operated from a working cabin placed above this house near the foot of the jib.

Sufficient cast iron ballast is provided to give a reserve of stability of 50 percent when the full working load of 150 tons is suspended at the maximum rake. Ladders and platforms are provided for giving access to the various parts of the machinery. The crane is placed on a heavily piled foundation, there being four groups of piles, one under each leg of the pedestal.

THE BOW OF THE BELLEROPHON, AFTER THE SHIP HAD STARTED DOWN THE WAYS.
(Photograph, Cribb, Southsea.)

The crane was designed for lifting the full load at a speed of 30 feet per minute, and to make a complete revolution in turning in 1¼ minutes. These speeds, however, could be considerably exceeded if sufficient accumulator power is available. In tests, a load of 200 tons was easily raised.

THE BATTLESHIP BELLEROPHON.

Following the successful trials of the *Dreadnought*, three new vessels of the same type were laid down, and have now been launched. The *Bellerophon* was put into the water July 27 last from the Portsmouth dockyard; the *Temeraire* on Aug. 23 from the dockyard at Devonport, and the *Superb* on Nov. 7 at the Elswick yards, Newcastle-on-Tyne. These ships are somewhat larger than the *Dreadnought* in displacement, although of the same overall dimensions. They represent certain improvements over the earlier ship, prominent among which are an increase in the length of the 12-inch guns from 45 to 50 calibers, and the raising of the central turret so that its guns may be fired over the after turret, and thus increase the astern fire of the ship.

The displacement is 18,600 tons, as compared with 17,900 in the *Dreadnought*, the difference being due to an increased fullness in the form of the hull, and also to a slight increase in the draft. The weight of the hull and armor is stated to be 11,800 tons as compared with 11,100 in the case of the prototype. The launching weight of the *Bellerophon* was above 7,000 tons, and of the *Temeraire* 7,475 tons. The length is given as 490 feet between perpendiculars, with a beam of 82 feet and a draft of 26 feet 3 inches.

Propulsion is by means of four screws actuated by Parsons turbines, with a designed shaft horsepower of 23,000 and a designed speed of ship of 21 knots. With 900 tons of coal at normal draft, it is estimated that the radius of action at 12 knots would be 5,800 nautical miles. It is possible, however, to carry a total of 2,500 tons of coal and oil.

The main defensive armor consists of a belt with a maximum thickness amidships of 11 inches, decreased to 4 inches at the

ends. The heavy guns are in turrets protected by 11-inch armor, while the two conning towers are armored with 11 inches (forward) and 8 inches (aft) of steel. The protective deck has a thickness on the slopes of 2¾ inches, decreased to 1¾ on the flat. Some protection has been given the ships in a cellular construction of the hull to avoid the disastrous effects which might be expected from a torpedo, thrown by either a torpedo boat or a submarine vessel.

The main battery consists of ten 12-inch guns, 50 calibers long, and located in pairs in five turrets. Three of these turrets are on the center line, one being on the forecastle, one on the after deck, and one aft of amidships, and at such an elevation as to be able to fire over the turret on the after deck. The two remaining turrets are placed, one on either beam, somewhat forward of amidships, and it is said that they can direct their own fire throughout a semi-circumference, from straight ahead to straight astern. This gives a broadside of eight of these powerful weapons, a theoretical bow fire of six, and a theoretical astern fire of eight. The probable maximum bow and stern fire at sea, however, would be four and six guns, respectively. The secondary battery, which is intended for defense against the attack of torpedo vessels, consists of 4-inch guns in place of the 3-inch weapons on the *Dreadnought*. In addition, there are five submerged torpedo tubes for 18-inch torpedoes, one tube being right astern, while the others are on the broadside and bows.

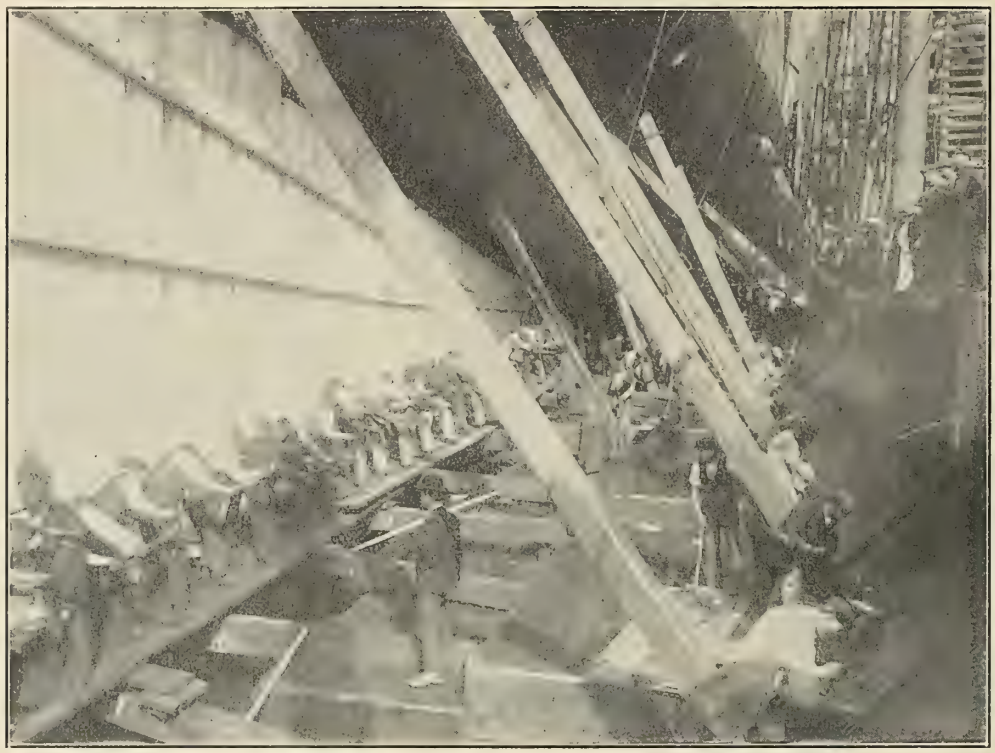
The ship will be steered by two rudders, as in the case of the *Dreadnought*, and of the new battle cruisers of the *Inflexible* type, and it is said that steering gear of a new type is to be fitted. One of the many minor departures from the *Dreadnought* design is the placing of the tripod mast astern of the two funnels, instead of between the two as in the type ship.

STERN OF THE BELLEROPHON BEFORE LAUNCHING, SHOWING STERN TORPEDO TUBE AND TWO OF THE PROPELLER STRUTS.

The French Liner Guadeloupe.

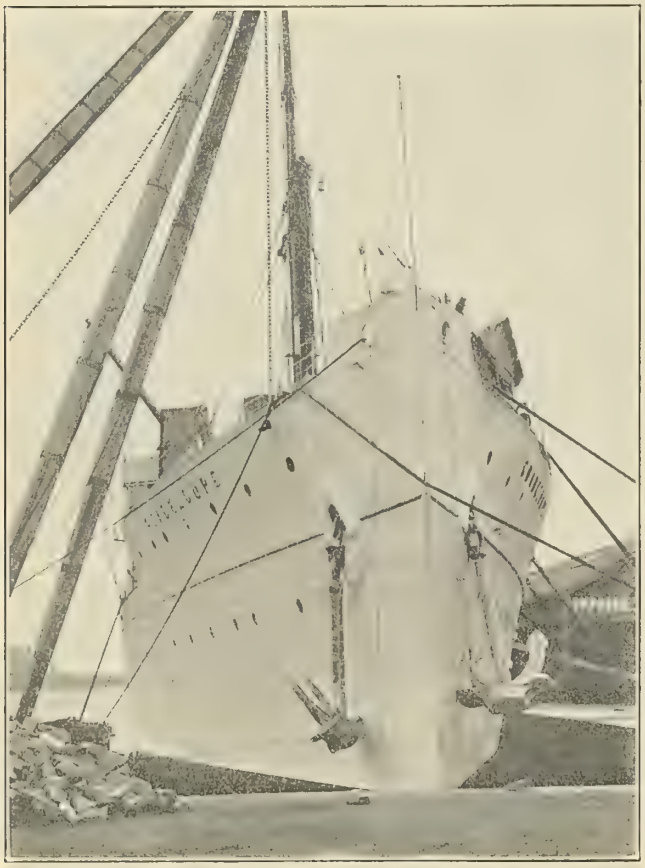
BY JULES PELTIER.

This vessel was given some description in our issue for September last, she having been launched from the yards of the Chantiers de l'Atlantique at St. Nazaire during the early spring. She entered into service by starting Sept. 27 last from Bordeaux for the West Indies. She is the largest and most modern vessel running between France and her American colonies, and is shortly to be followed by her sister ship, *Perou*. The ship has the following dimensions:

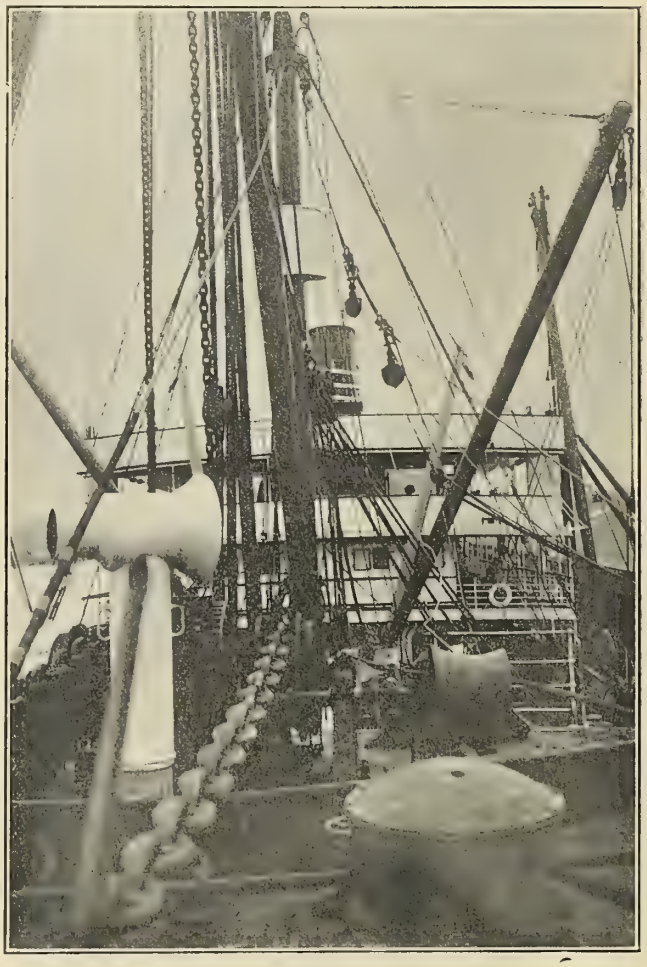


"SETTING UP" THE BELLEROPHON, JUST PREVIOUS TO HER LAUNCHING.
(Photograph, Cribb, Southsea.)

	Meters.	Feet.
Length over all	136	447
Length between perpendiculars	131.84	432
Extreme beam	15.92	52.2



A BOW VIEW OF THE GUADELOUPE.



VIEW LOOKING AFT FROM FORECASTLE.

THE FRENCH WEST INDIA LINER GUADELOUPE, BUILT BY THE SOCIETE DES CHANTIERS DE ST. NAZAIRE.

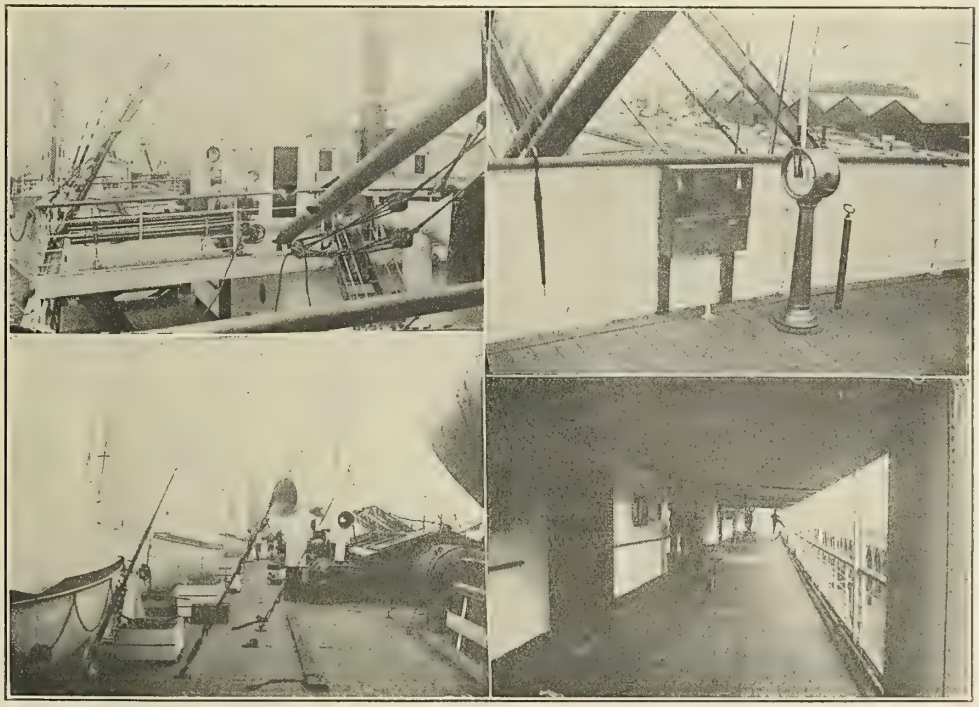
Depth	9.57	31.4
Mean draft	7	23
Gross register tonnage	6,585	
Net tonnage	2,968	

There are two propellers actuated by triple expansion engines, each in a separate watertight compartment. The cylinders have diameters of 27, 43 and 72 inches, with a stroke of 48 inches, and are operated at 90 revolutions per minute. Steam is supplied by six single-ended Scotch boilers with a length of 10 feet 11 inches and a diameter of 14 feet 1 inch. Each is fitted with three furnaces, the total grate and heating surfaces being, respectively, 345 and 13,451 square feet. The ratio is 39 to 1. The boilers of the *Perou* are fitted with Pielock superheaters, while the engines have Lentz slide valves. The boilers and engines of the *Guadeloupe* are fitted with the usual arrangement, which fact will permit the owners to obtain splendid comparative results to guide them in future construction.

On trial trip the *Guadeloupe*, with a displacement of 9,600 tons, obtained 17 knots with 6,580 horsepower, the boilers working under Howden's forced draft system.

The outfit includes a set of dynamos supplying electricity for lighting, ventilating, operating capstans and boat winches, and various signaling and telltale devices. The refrigerating plant will permit the ship to carry fruits and other perishable goods. The twelve steel lifeboats are fitted with Welin quadrant davits.

The question of subsidy entered very largely into the construction of these vessels. It is estimated that the shipbuilding subsidy for the hull of each amounted to 925,192 francs, while for the machinery the total is given as 401,250 francs. This makes an aggregate of 1,326,442 francs (£52,550, or $255,800). As the vessels also come under the merchant cruiser act, they will receive daily for each ton up to 3,000 gross register 4 centimes; 3 centimes for each ton between 3,000 and 6,000, and 2 for each subsequent ton. This would make for each a total of 221.70 francs per day, subject to an increase of 30 percent because of the speed, making a total of 288.20 francs per day. This aggregates 103,755 francs per year (£4,112, or $20,020). The combined shipbuilding and ship operating subsidies thus obtained for these vessels ought to make them a very profitable proposition for their owners.



VARIOUS DECK SCENES ON THE STEAMSHIP GUADELOUPE.

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Changes to be made in copy, or in orders for advertising, must be in our hands not later than the 5th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 1st of the month.

Battleship Construction in Britain.

Up to the present time the British Navy is the only one which has afloat any vessels of the distinctively *Dreadnought* type: That is to say, vessels whose primary armament includes eight or more guns of the highest power, and whose secondary armament is of small weapons, intended solely for use against torpedo craft. The original *Dreadnought* has been in service for more than a year, and the three sister ships, of slightly increased displacement, *Bellerophon, Temeraire* and *Superb,* are all in the water. Three new ships are about to be laid down, two of them being, respectively, the *St. Vincent* and the *Collingwood.* These are reported to embody a somewhat further increase in displacement and effectiveness upon their predecessors of the *Bellerophon* type. In addition to this splendid array, we must note the three so-called armored cruisers, which are in reality, by virtue of their offensive and defensive powers, battleships of great strength and tremendous speed, and which go by the names of *Indomitable, Inflexible* and *Invincible.* This makes a total of ten ships, of which seven are already afloat. As compared with this, Germany has four ships of 19,000 tons on the stocks; the United States has two of 16,000 tons and two of 20,000 tons building; and Brazil has three large ships building in England. This exhausts the list of *Dreadnoughts* proper. Ships of somewhat similar characteristics, however, are not wanting on the stocks of other nations, for France is building six vessels of the *Danton* type, of 18,350 tons; Japan has already launched two vessels of the *Satsuma* type, of 19,500 tons, and is reported to have others in hand; and Russia has a program calling for the construction of several such vessels.

The great feature of all of the ships of the *Dreadnought* type is the possibility of great concentration in the fire of heavy guns, and of an exceedingly effective attack at long battle ranges. Our readers need not be reminded that of two shells with the same initial velocity, that one which is heaviest will best maintain its velocity, and hence its energy of impact, and the greater the excess weight the better will this velocity be maintained. A 12-inch shell would be exceedingly dangerous at a point where a 6-inch projectile would have lost almost all of its kinetic energy. It is for this reason that the ships in question have been fitted with these heavy guns in such a way as to give a tremendous fire at great distances. Each of the ten British ships above mentioned can concentrate on either broadside eight 12-inch guns, with a bow and stern fire of from four to six. The American *Michigan* class can place eight guns upon the broadside and four at bow and astern. The *Delaware* class can concentrate ten of these guns upon the broadside and four at either end. The German ships are fitted with 11-inch guns, and, while details are not thoroughly well known, it is believed that ten can be brought to bear upon the broadside, and six forward or aft. The Brazilian ships are reported to be something of a compromise between the *Dreadnought* and the *Indomitable,* so far as distribution of guns is concerned, and to have a broadside battery of no less than ten of the 12-inch size.

The Naval Architects' Convention.

In this number will be found reports in brief covering the various papers and discussions at the recent convention of the Society of Naval Architects and Marine Engineers, in New York. It is our purpose to publish ultimately about half of the fourteen papers presented, but demands upon our space make it possible for us to publish in this issue only two of the seven or eight which will ultimately appear. As has been our custom for some years past, we are reporting the salient points of the discussions, as well as giving abstracts of all the papers, feeling, as we do, that in many cases there is as much value in the discussions as in the original papers, because they bring to bear on any given subject the united efforts of many minds,

approaching the problems from almost as many different points of view. We have not considered it necessary to go so extensively into the discussions as has been done on certain occasions in the past, but have carefully excised all remarks which did not bear directly upon the subject in hand, or upon one very closely related to it.

Both papers which we are publishing in this number are of particular note, and for different reasons. Mr. Taylor's paper, describing the effects of experiments to determine the location of stream lines upon the hulls of ships, may almost be said to be epoch-making in its originality and in the unique results obtained. It has resulted in upsetting, to a very large degree, all preconceived ideas with regard to the flow of water around the hull of a ship during the progress of the ship through the water. As a matter of fact, these experiments seem to indicate that a ship virtually climbs upon the water in the forward portion and then slides down from this pinnacle in the rear. This fact will, perhaps, explain some things which have heretofore been rather obscure and imperfectly understood. For instance, we have all noticed the peculiar position taken by a very fast torpedo boat or motor boat when running at full speed. The bow tends to rise out of the water, and, whenever the speed becomes high enough, approximating to a certain relation with the square root of the length, portions of the keel may become visible. In extreme cases, it has even been found that as much as one-third of the length of the vessel has emerged from the water, and the tendency seems to be for the entire hull to climb up upon the surface. This has been noted in connection with the articles upon motor boats, appearing in our columns in 1906, from the pen of Professor Durand. It was stated by this authority in connection with this subject that there seems to be indication of "a marked decrease in displacement at these high speeds, a condition indicated also by observations on the boat itself under running conditions. It should be noted that, while such possibilities are plainly indicated for very high speeds, they must be purchased at some sacrifice of seaworthiness and weatherly qualities in rough water."

It goes almost without saying, that an investigation of this sort, giving results so totally at variance with what has heretofore been accepted as a normal condition of operation, will scarcely fail to exert a marked influence upon the design of vessels intended for the utilization of high speeds. Now that there is something definite known about the manner in which the enveloping medium traverses the length of the vessel, the form of the hull may undergo certain modifications to take advantage, so far as may be, of this action of the water. The results of long years of experience in the designing of hulls, however, have developed forms which are already probably not unsuited for the stream lines actually occurring in practice. The forms have been developed, however, without relation to a true knowledge of those stream lines, and, now that we have a beginning of such knowledge, it is more than possible that alert designers may make some marked modifications. The general form, however, will scarcely lend itself to much change, nor is such change very necessary, because we have already in many instances reached about the lowest limit of resistance under specific conditions of power and carrying capacity.

The other paper which we are publishing this month happens to be the first one read before this society which covers in any manner whatever the performance of marine turbines in service. The paper is extremely incomplete, by virtue of the great paucity of information in it, and it has been assailed from various sides as having many elements of incorrectness, in addition to its incompleteness. Nevertheless it has had a certain value in stimulating discussion and in bringing out facts and opinions from those who have had an opportunity to watch the performance of the vessel therein described.

One of the main criticisms of the paper lies in the curve between revolutions and speeds, which shows a tendency to become asymptotic at a speed of about 17½ knots, whereas the builders of the vessel had already tested her to a speed of about 19 knots, without developing any such tendency. It is more than likely that the discrepancy here noted lay in the devices for measuring speed, which, while faithfully recording speeds at all times during the run, yet at high speeds may have been so unsuited for this work as to have given erroneous results. The curve between power and revolutions runs up about as might have been expected, and the form of the hull is such as to make it practically out of the question to have such an extreme falling off in speed without some severe failing in some part of the mechanism, such, for instance, as the propellers. Numerous "points" were taken and plotted in determining this portion of the curve. The discrepancy cannot, therefore, be placed at the door of faulty or incomplete observations.

Be this as it may, we cannot but look with suspicion upon the indications of patent logs. They are extremely useful in many ways in recording speeds, etc.; but as an instrument for exact measurements, measurements upon which scientific deductions may safely be based, no device of this sort can be thoroughly relied upon. In one respect the patent log has an advantage over exact measurements between points, in that it automatically takes account of all tidal influences operating upon the waters through which the vessel is passing. This, however, is more than discounted by the ease with which such a piece of mechanism may get out of adjustment, while it is perfectly easy, with proper facilities, to take account of the flow of the tide over the course.

Progress of Naval Vessels

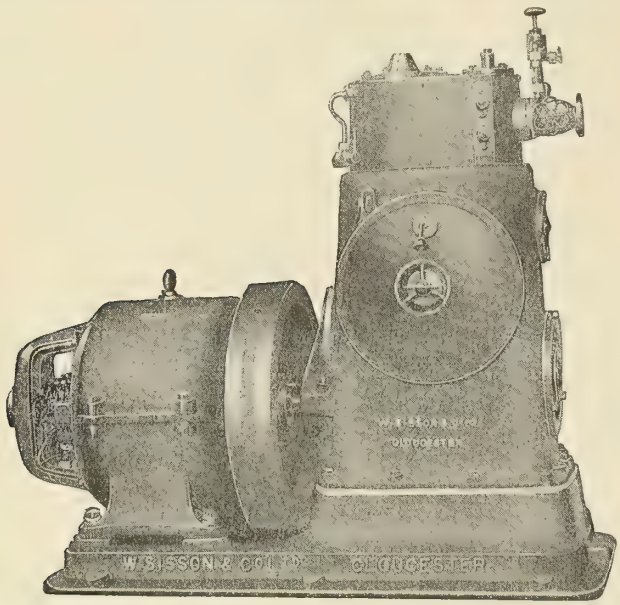
The Bureau of Construction and Repair, Navy Department, reported under date of November 9, 1907, the following percentage of completion of vessels building for the United States Navy:

	Tons.	Knots.		Oct. 1	Nov. 1
BATTLESHIPS.					
Mississippi	13,000	17	Wm. Cramp & Sons	94 96	96.82
Idaho	13,000	17	Wm. Cramp & Sons	87.54	89.41
New Hampshire	16,000	18	New York Shipbuilding Co.	85.3	90.2
South Carolina	16,000	18½	Wm. Cramp & Sons	24.66	28 83
Michigan	16,000	18½	New York Shipbuilding Co.	25.7	29.1
Delaware	20,000	21	Newport News S.B. & D.D.Co	0.65	2.33
North Dakota	20,000	21	Fore River Shipbuilding Co.	0.00	4 23
ARMORED CRUISERS					
North Carolina	14,500	22	Newport News Co.	91.5	93.33
Montana	14,500	22	Newport News Co.	84.62	87.38
SCOUT CRUISERS.					
Chester	3,750	24	Bath Iron Works	90.64	92.7
Birmingham	3,750	24	Fore River Shipbuilding Co.	89.46	90.79
Salem	3,750	24	Fore River Shipbuilding Co.	86.99	88.52
SUBMARINE TORPEDO BOATS.					
Cuttlefish	—	—	Fore River Shipbuilding Co.	99.	99.
Octopus	—	—	Fore River Shipbuilding Co.	99.	99.

ENGINEERING SPECIALTIES.

A Ship Lighting Set.

Messrs. W. Sisson & Co., Ltd., Gloucester, have placed on the market a ship-lighting set, consisting of a "Sisson" single-cylinder inclosed high-speed self-lubricating engine direct coupled to a dynamo. Electric lighting is now so much used on board ship, and the inclosed type of engine is coming into such favor with marine engineers that there is considerable demand for this type of engine, and a large number have been



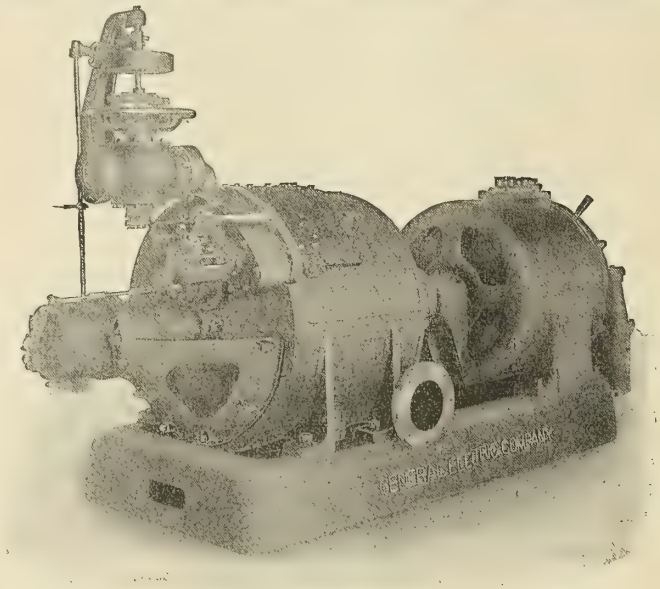
constructed for driving dynamos for ship lighting. An inclosed self-lubricating engine is, for obvious reasons, to be strongly recommended in preference to the open type; and this engine combines a neat appearance with compactness, simplicity, very easy access, good governing, ease of adjustment and economy in oil.

It embodies several features distinct from the general run of inclosed engines, for example, the governor is of patent crankshaft type, inclosed in the crank chamber, and automatically lubricated along with the other working parts. It controls the eccentric of the steam distribution valve, thus giving automatic expansion. It has a "throttling" action at low loads, and secures close regulation and good steam economy under varying loads. The connecting rod is so arranged that by one very simple operation, occupying a few moments only, both top and bottom bearings are adjusted to a nicety. The door is very large, light, and perfectly oil tight, is quickly removed and replaced, and gives ready access to the working parts of the engine.

Horizontal Curtis Turbine Generating Sets for Marine Service.

Until the attention of the public was called to marine turbine development by the recently built turbine-driven liners this source of power for marine use had hardly received its due amount of consideration. The construction of these liners calls attention to other turbine installations on shipboard, and directs the public gaze to the progress made in this line. The rapid development of electric drive, and the immense widening in the scope of electrical applications in marine service, require such an increasing amount of electrical power that engine-driven units of suitable size for general use aboard ship are coming to occupy altogether too much space. It is to meet these changing conditions that the steam engine is being displaced by the Curtis horizontal turbine, especially in lake service, where it is particularly valuable, both on account of its low head room and the high efficiency obtainable from condensing operation. In the illustration showing a complete 75-kilowatt set, the turbine is shown at the left, the generator being at the further end of the base. This cut also shows the throttle and governor.

Nowhere has the expansive force of steam been utilized to greater advantage than in the steam turbine. The directed kinetic energy of the steam is consumed in rapidly rotating a

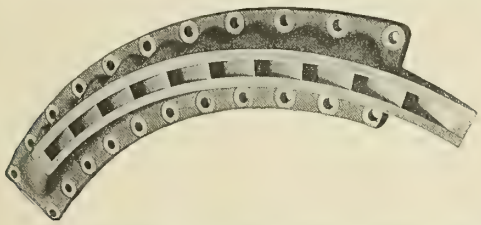


large disk. The numerous small radial buckets set in the periphery of this disk present an enormous area to the entering steam, which strikes the buckets after passing through stationary inclined nozzles set in a plane tangent to the disk. The nozzles (see figure) are inclined in the direction of rotation of the disk, and at about 20 degrees to its plane, so that instead of entering from the end of the buckets, as the stream in a Pelton water-wheel, the flow enters at the sides.

On leaving the stationary nozzles, the steam passes through a small clearance space and impinges on the concave surface of the buckets, imparting a rotary motion to the disk. After leaving the movable buckets the direction of the steam flow

is so turned that, although still acting in a plane tangent to the disk, its direction is practically reversed. As the steam is still under considerable compression it is quite desirable to make use of its remaining energy by the use of another set of revolving buckets, or even by several more. The direction of flow being reversed by each set of movable buckets, it must be redirected each time, in order to be used on the next set.

While the clearance between blades is so small as to be almost negligible, there is absolutely no contact between stationary and rotating parts except at the shaft bearings. Simplicity was particularly sought after in the construction of the Curtis turbine generator, so that it requires a minimum of attendance. Oil is supplied to the bearings under slight pressure, but none enters into the turbine case, thus insuring



a perfect freedom from oil in the exhaust steam, allowing the latter to be used in a heating system, or returned direct to the boilers after condensation.

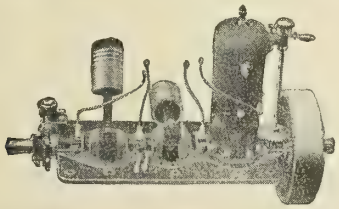
Horizontal Curtis turbine-driven units are now made in sizes from 15 to 300 kilowatts capacity. In the sizes up to 25 kilowatts, both generator and turbine are put on the same shaft, which runs in two bearings. Larger sizes are assembled on a two-part flexibly coupled shaft running in four bearings. At page 293 of our July (1907) number was shown one of these sets, of 25 kilowatts, on the Hudson River steamer *Hendrick Hudson.*

The turbine speed is governed by changing the number of nozzles through which the steam enters. This speed regulation is carried out by a centrifugal governor, which, mounted on the end of the turbine shaft, so varies the steam in-take as to give constant speed at all loads. Owing to the small weight, the turbine sets are easily installed, and as they are entirely free from reciprocating parts, require a foundation of but very moderate size and weight. They are supplied by the General Electric Company, Schenectady, N. Y.

The Ferro Marine Engine at the New York Show.

The Ferro, novel, interesting and the subject of lively comment as exhibited at each show last season, will reveal the same advanced ideas for which the Ferro Machine & Foundry Company, of Cleveland, is said in one year to have become prominent.

Entire absence of water pipes for conducting the water between cylinders, pump and discharge—great rigidity and

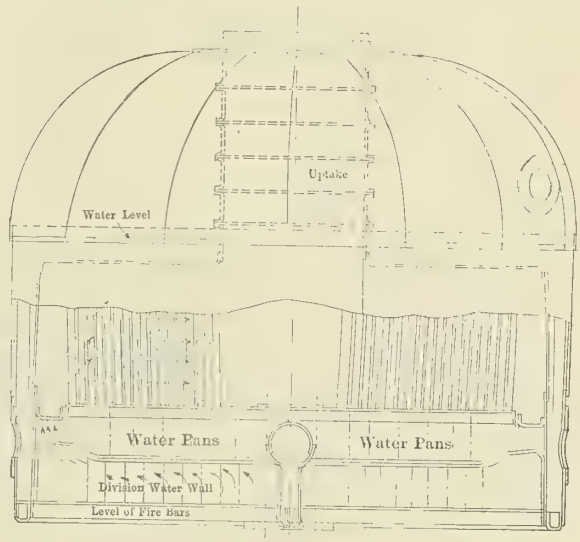


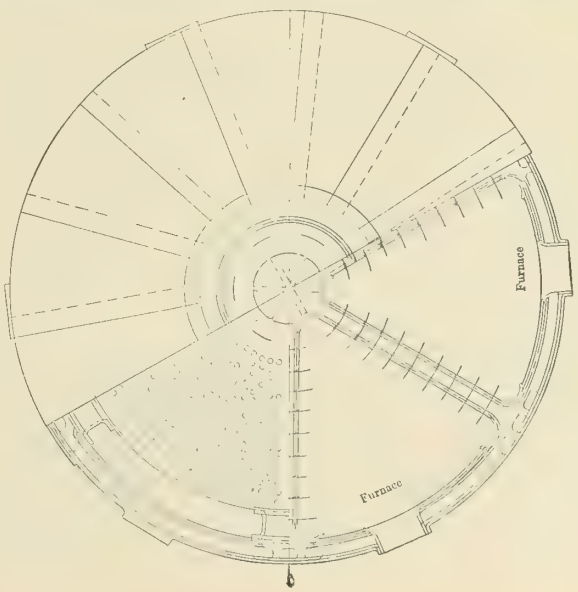
strength of construction, with cylinders supported on base independent of the crank shaft bearings, thereby eliminating transmission of undue stresses and strains between the various parts—pressure oiling system, in which all the oil is placed in one tank, and independently distributed without pumps automatically to each bearing surface; compact combined water-cooled in-take and exhaust header, especially designed for conveniently attaching exhaust connection to either air muffler, water muffler or submerged exhaust; sensitive timer adjusting lever to give instantaneous graduated speed changes in connection with carbureter throttle; wire seals on all bolted moving parts, replacing dangerous lock nuts; these, together with other details which can best be seen, should prove distinctive.

A working boat engine in a powerful 7½-horsepower single cylinder and 15-horsepower double cylinder, of great endurance and simplicity of parts and of a type claimed to have produced remarkable results during the past season in fishing, were also shown. In all, besides "Instruction Model," ten different sizes and various types of engines were exhibited, in horsepower from 1½ to 25, one, two and three cylinders, weights 38 pounds to ¼ ton, with and without boat, exhaust reverse gear, ignition and propeller equipments and accessories.

Haystack Boilers.

Two of the largest of these watertube boilers are being built by Hutson & Sons, Limited, Kelvinhaugh Engine Works, Glasgow, who make a specialty of this type. The object of the haystack boiler is to reduce weights so as to have with all contents a relatively small total weight in proportion to the power developed, and combined with these features the property of raising steam quickly. This is of prime importance in the paddle steamers, for which this





boiler has been so largely used. Successful examples of this type of boiler are very usual on Clyde river steamers, where a large number have these fitted, and also on many boats plying from Bristol Channel and South of England ports.

Probably no single watertube boiler possesses all the merits of an ideal boiler, and in nearly every case the attempt to gain certain advantages brings about corresponding disadvantages; but it is stated that (up to 120 pounds per square inch) the haystack boiler provides for ordinary pressures, good steaming and efficiency, which are absolutely indispensable, on a low weight. In many boilers the circulation is to a very great extent casual, but in a well designed haystack boiler it is systematic, the water entering through tubes at one end, and passing through in a continuous stream, being to a certain extent converted into steam as it goes. It will be seen from the illustrations that the heating surface is almost wholly composed of a series of vertical tubes up which the water circulates; these tubes are secured in the usual way, and serve to connect the top and bottom tube plates. Sometimes external down cast pipes are fitted on the sides of boiler to assist circulation, but it is doubtful if they are of any material advantage.

The builders give the actual weights of a boiler, including water and firebars complete, suitable for 2,500 horsepower, which works out at the rate of 74.5 pounds per indicated horsepower developed. Compared with this, ordinary boilers fitted with forced draft on the closed stokehold principle, for the same power, work out at 110 pounds per horsepower, showing a saving of weight on boilers alone of nearly 30 per-cent.

TECHNICAL PUBLICATIONS.

Bureau Veritas, 1907-1908; thirty-eighth year. General List of Merchant Shipping. Two volumes: steamers, size, 10 by 7½ inches. Pages, 1,700. Sailing vessels: size, 7¼ by 9¾ inches. Pages, 1,300. 1907. Paris: 8 Place de la Bourse. London: 155 Fenchurch street, E. C. Price of the complete work, £3-3s. ($15). Steamers, £1-15s. Sailing vessels, £1-10s.

This work requires no introduction, it being the regular list of all merchant vessels of the various maritime powers, with the usual particulars in the way of dimensions, powering, ownership, builders, etc. The books include also illustrations of the various types of vessels, together with tables showing the total tonnage and number of vessels of the various powers, as well as alphabetical lists of owners of fleets of vessels, with the respective tonnages. In addition to this, tables are given showing all the vessels under the several flags, arranged in order of signal letters. At the end of the volume of steamers is given a table showing all the drydocks, patent slips, floating drydocks and marine railways in all the ports of the world. There are also alphabetical lists of steamers arranged according to tonnage, under several sub-divisions, but including no vessels of under 600 tons. No less than 114 steamers of over 10,000 tons are here included, of which nine exceed 20,000 tons each.

Nautische Bibliothek. Size, 5 by 7½ inches. Three volumes. Berlin, 1907. K. W. Mecklenburg. Price, 1.50 marks (6s.) per volume.

Volume I. (90 pages): The Position of the Ship Officer in the Merchant Marine. By Dr. F. Bolte, Director of the School of Navigation in Hamburg. The work is based entirely on German practice, and describes, among other things, the school of seamanship in Hamburg, the North German Lloyd cadet schoolship and various private schoolships for fitting young men for the higher ranks in the operation of seagoing ships. This volume takes up the various conditions to be observed in connection with entering the service through the navigation and seamanship schools, and treats also of the position of the cadets with regard to military service.

Volume II. (125 pages): The Cadet Service. By Captain G. Reinicke. This volume includes a number of illustrations of the various parts of a ship and her rigging, together with the compass, and details of sails. The work is full of advice for the young man starting in on a seafaring career, chapters being given covering the first day of work, the departure from port, the watch, the first day at sea, loading and unloading, and particulars concerning service in various oceans and under various conditions. The appendix treats of the rations and the sanitary requirements on shipboard, besides giving a table of measures commonly in use.

Volume III. (pages 122; figures 32; tables 10): Elementary Navigation. By Dr. F. Bolte. This includes coastwise and deep sea navigation, with astronomical observations and the reckoning of latitude and longitude. The appendix deals with Mercator's projection, the influence of the ship's mechanism upon the compass, triangulation and various features dealing with the use of instruments. The tables cover tangents and corrections for refraction, parallax, etc.

Transactions of the Institution of Naval Architects for 1907. Volume XLIX. Edited by R. W. Dana, M. A. Size, 8½ by 11 inches. Pages, 334 + LII.; folding plates, XLII.

In addition to the list of officers and members of the Institution and the by-laws and regulations, there are found in this number the papers read at the spring meetings in London, in March, and at the summer meeting in Bordeaux in June. The best indication as to the contents lies in a list of the papers, as follows:

The Influence of Machinery on the Gun Power of the Modern Warship; Safe Submarine Vessels and the Future of the Art; On Some Points of Interest in Connection with the Design, Building and Launching of the *Lusitania;* The Evolution of the Modern Cargo Steamer; Cranes for Shipbuilding Berths; Torsiometers as Applied to the Measurement of Power in Turbines and Reciprocating Engines; Torque of Propeller Shafting—Some Investigations and Results; Propeller Struts; Experiments with Dr. Schlick's Gyroscopic Apparatus for Steadying Ships; Approximate Formulæ for Determining the Resistance of Ships; The Application of the Integraph to Some Ship Calculations; The Causes and Prevention of Fire at Sea; Modern Floating Docks; Some Phases of the Fuel Question; Some Practical Points in the Application of the Marine Steam Turbine; Structural Development in British Merchant Ships; Further Results of Submarine Signaling by Means of Sound; On the Use of Hydraulic Riveting in the Construction of the *Mauretania.*

The frontispiece is a photogravure of Sir Edward J. Reed, K. C. B., F. R. S., who was at one time naval construction director of the Admiralty.

The Mechanical World Pocket Diary and Year Book for 1908. Twenty-first annual issue. Size, 4 by 6 inches. Pages, 391. Figures, 57. Manchester: Emmott & Company, Ltd. Price, 6d. net.

Within a small compass, in a book conveniently carried in the pocket, have been collected a large number of tables of engineering data of all descriptions, from the usual mathematical and trigonometrical tables to horsepower, steam and vacua tables, tables of the properties of I and Z-bars, shafting and the strength of materials, electrical constants and wiring tables, hydraulic data, tables of bolts, nuts and threads, conversion tables between metric measures and the corresponding British units—in short, all of the usual data and tables to be found in the general engineering reference books. In addition to this are to be found many "chapters" or notes on various subjects

of an engineering character, such as engines, boilers, valve setting, pumps, oil and gas engines, belt and rope driving, electric machinery, power transmission and devices, and a multitude of other items of interest to the engineer.

In the rear of the book are a diary and blank pages for memoranda. A splendid and very complete index renders the book exceedingly easy of access, and adds enormously to its value as a work of ready reference.

The Use of the National Forests. By Gifford Pinchot. Size, 5 by 7 inches. Pages, 42. Half tone plates, 7. Washington, 1907. United States Department of Agriculture.

This little book was designed to explain just what the national forests of the United States are, what they are for and how they should be used. It is not a treatise on forestry, but it gives good practical advice as to what not to do in the conduct of large stretches of timberland. The questions of the water supply, the fire hazard, the proper cutting of timber, and the use of the land for grazing purposes, where the trees are sufficiently open to allow this, are among the topics discussed in the book. At the end is a list showing the size of the various forest preserves in the United States on April 1, 1907, the aggregate of 150 forests or public parks being about 143,000,000 acres (223,100 square miles). The largest single unit in this immense total is the Yellowstone National Park, which contains 8,317,880 acres. The state with the largest representation is California, which has nearly 22,000,000 acres, but Idaho and Montana are close behind, with more than 20,000,000 acres each.

It will be noted that the total acreage of these forests is much greater than the entire area of either France or Germany, and that it is nearly twice as great as the area of Italy or of the United Kingdom.

Hydraulics. By S. Dunkerley, D. Sc. Size, 5½ by 8½ inches. Pages, 343. Figures, 269. London and New York: Longmans, Green & Company. Price, 10/6 net; $3.

This is the first of two volumes on the subject of hydraulics, and covers hydraulic machinery. The second volume, which has not yet appeared, is devoted to the resistance and propulsion of ships. The present volume is based on lectures on hydraulic machinery given in the course for engineers and constructors at the Royal Naval College, Greenwich, and is intended as a text book for use in universities and the royal navy, as well as for designers of hydraulic machinery.

The work is divided into seven chapters, followed by a set of examples and an index. The chapters deal respectively with the flow of a perfect fluid; fluid friction; pressure machines; reciprocating pumps; hydraulic turbines; centrifugal pumps, and the researches of Prof. Osborne Reynolds upon viscosity, sinuosity, eddies, resistance in tubes and lubrication.

The illustrations are nearly all line cuts, and serve to render the text easily readable, and to explain its meaning thoroughly. The first part of each chapter is taken up with theoretical considerations, the principles being developed without the use of calculus; while the second section takes up machines and devices for the production or application of hydraulic power, with copious illustrations. Among the most interesting items from the point of view of the marine engineer are discussions on hydraulic riveters, hydraulically operated bulkhead doors, hydraulic cranes and brakes and other devices for the operation of heavy guns on shipboard. The reciprocating, turbine and centrifugal pumps are also interesting, and are given in much detail.

Omission.—The mine-laying steamer *Capt. A. M. Wetherill,* described at page 502 in our December number, was built by the T. S. Marvel Shipbuilding Company, Newburg, N. Y.

QUERIES AND ANSWERS.

Questions concerning marine engineering will be answered by the Editor in this column. Each communication must bear the name and address of the writer.

Q. 387.—On page 458 of your issue for November is the statement that the index n in the expression $H_1:H_2::V_1^n:V_2^n$ is very high, and that this index, which is often assumed as 3, becomes 4.58 for the *Democratie* and 5.98 for the *Justice.* What does this mean, and how do you get these results? N. S. Y.

A.—It has long been known that in order to increase the speed of a ship, it would be necessary to increase the power in a much higher ratio than the increase of speed desired. Experiments have shown that under ordinary conditions, and for a speed not excessive for the size and type of ship under consideration, the power would increase about as the cube of the speed. This means that if we are going to double the speed, we will have to supply eight times the power required for the lower speed; and similarly for other proportions of increase in speed. To express this algebraically, $H = aV^n$, where H represents the horsepower, V represents the speed in knots, a represents some coefficient, which will vary for different ships, but will be approximately constant for any one ship under conditions which are not abnormal, and n is the index of the power of the speed, according to which the horsepower varies. As stated above, this index is usually taken as 3; that is to say, it is usually assumed that the horsepower required will vary as the cube of the speed.

For the particular instance in question, however, this index does not fit the case. We might make a table, showing the various points involved, as follows:

	Démocratie.	*Justice.*
V_1	17.39	17.94
V_2	19.44	19.43
H_1	11,472.	11,520.
H_2	19,190.	18,548.
$V_2:V_1$	1.1179	1.0831
$H_2:H_1$	1.6668	1.6109

It will be noticed that V_1 represents what we have termed the "intermediate speed" of the vessel in knots; V_2 represents the highest speed; H_1 represents the horsepower required for the intermediate speed; and H_2 the horsepower required for the highest speed.

It will also be noticed that the ratio of increase in the horsepower ($H_2:H_1$) is much greater than the ratio in speed ($V_2:V_1$). The most convenient way to obtain the index of the power according to which these vary is by the use of logarithms as follows:

Log. $V_2:V_1$	0.04840	0.03467
Log. $H_2:H_1$	0.22189	0.20707

By dividing log. $H_2:H_1$ by log. $V_2:V_1$, we obtain the index required. This is 4.58 for the *Démocratie,* and 5.98 for the *Justice,* as mentioned in our November number.

Q. 388.—Kindly give me some information on lining up a steeple compound tugboat engine, the main bearings of which have worn until the engine shaft is quite low. As the shaft has no spring bearings, I don't know how much to raise the shaft, for it is impossible to put the boat in dry-dock and remove the shaft, to run a line through the stern tube. Shaft is about 10 inches in diameter. M. C. M.

A.—There are three methods which appear available under certain conditions:

(1) If the original clearance at the upper end of the upper cylinder is known, that cylinder cover could be taken off and the engine turned until the piston reaches the top of the stroke. The present clearance could then be noted, and adjustment of the main bearings could be made until the clearance is brought to the old figure.

(2) In case the original clearance is not known, and the line shafting has retained its alinement, it would be possible to run a straight line by means of a very taut wire parallel to this

line shafting, and through the engine in such a way that the position of this wire with regard to the axis of the line shafting could be compared with the position of the wire with regard to the crank shaft in the forward bearing. This bearing is the one which has probably suffered most in wearing down, and is, therefore, the one where best results would be obtained in the way of observation, as above outlined. Unless the wire is stretched very tight, however, it will be unreliable as a basis for comparison, and it will have to be so placed as to be *exactly parallel* to the portion of the shafting which has not got out of alinement.

(3) If neither of these methods can be used by virtue of there being no portion of the shafting upon which reliance can be placed, there seems to be still another method left, provided the original drawings of the engine can be obtained. These drawings would show the position of the center of crank shaft with regard to some finished surface on the bedplate, or, with regard to some finished surface at the bottom of the cylinder. Direct measurements could then be made, and the defect remedied in accordance with results thus obtained.

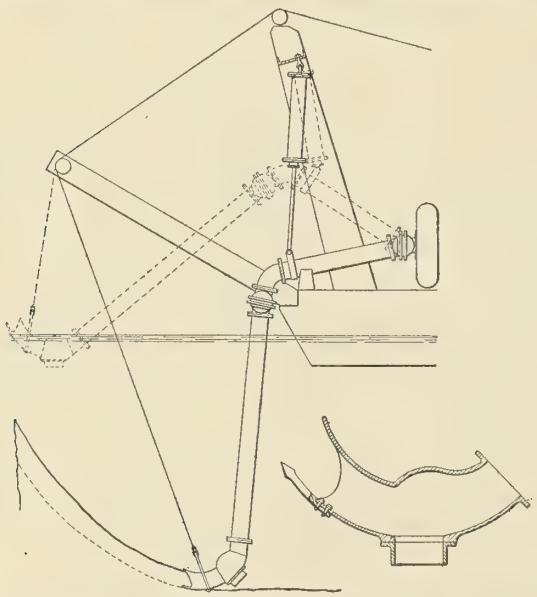
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

867,492. HYDRAULIC DREDGE. CHARLES A. FRAYER, MILWAUKEE, WIS., ASSIGNOR TO ALLIS-CHALMERS COMPANY, MILWAUKEE.

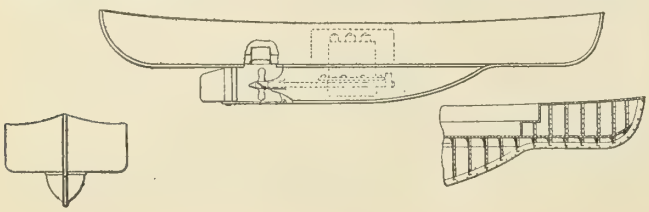
Claim.—1. In a hydraulic dredge, a shovel, a hollow arm therefor



for conveying away material dug by the shovel, a separate water inlet for the hollow arm, and a recess within the arm opposite the water inlet.—Four claims.

867,654. HULL FOR VESSELS. SAMUEL GOLDEN, BUFFALO, N. Y.

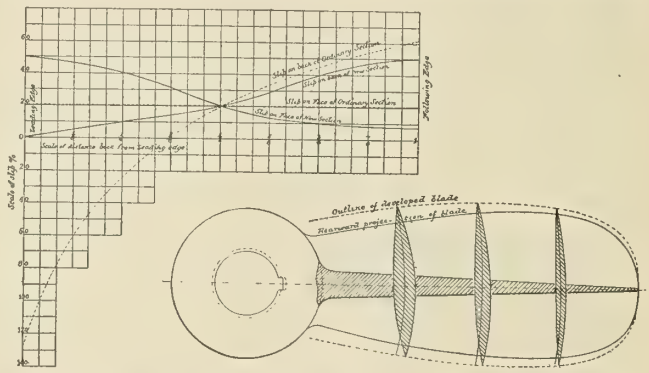
Claim.—The combination of a vessel hull having a hollow horizontal bottom extension of less length and width than the hull, said extension being overhung by the bottom of the hull at the front, rear and sides, the front portion of the extension sloping from the bottom of the hull downwardly and rearwardly to the bottom of the extension,



the front and rear ends of the extension being arranged at a distance rearwardly and forwardly of the front and rear ends of the hull, and the bottom of the hull extending approximately at right angles outwardly from the upper ends of the sides of the extension, a propelling engine arranged with its lower portion in the extension, a horizontal propeller shaft extending from engine rearwardly through the extension, a propeller arranged at the rear end of said extension, and a rudder arranged in rear of propeller, underneath the overhanging bottom of the rear portion of the hull. One claim.

867,853. SCREW PROPELLER. DAVID W. TAYLOR, WASHINGTON, D. C.

Claim.—1. A propeller blade whose developed section is derived from a curved directrix extending from the forward or leading part of the



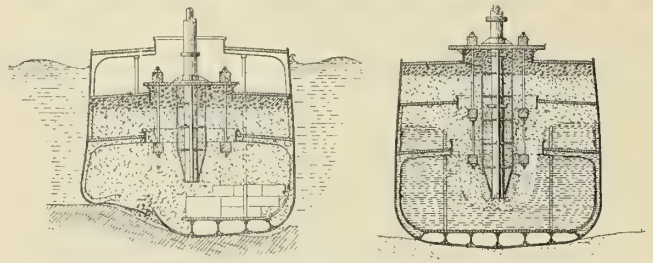
blade to the following edge, the blade having the forward half of its back parallel to said directrix, the rear halves of the back and face of the blade converging to meet the directrix at the following edge and the forward half of the face of the blade determined from the thickness of the section and the curved back of the blade.

3. A propeller blade, the rear halves of whose developed sections are symmetrical to a curved directing surface of axially increasing pitch, and constant radial pitch.

7. A propeller blade the thickness of any section of which at any point of its rear half is proportionally distributed on both sides of a curved directrix, the whole thickness of the blade section at such point being proportional to the ordinates of a curve of sines plotted upon the length of the entire section, which length is taken to represent 180 degrees. Seven claims.

867,983. MEANS AND APPARATUS FOR RAISING SUNKEN VESSELS. SIMON LAKE, BRIDGEPORT, CONN.

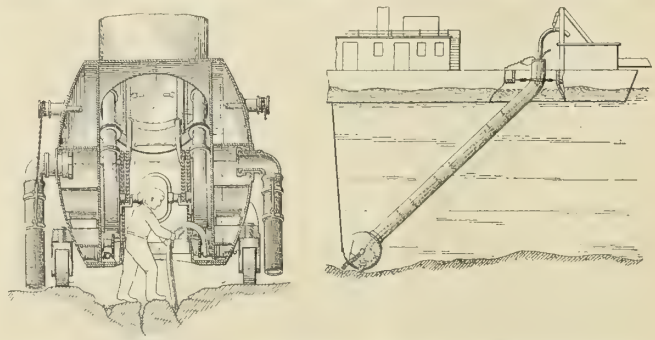
Abstract.—The invention consists broadly in displacing the water in the interior of a sunken vessel by pumping buoyant material, either solid or capable of being solidified, into the vessel until the dead weight of the vessel, its fittings and cargo are overcome by such



material. The buoyant material preferably is cork, in the form of blocks of a size that can be readily handled in a centrifugal or other force pump, the cork being first coated or boiled in paraffin or other suitable substance to make it more impervious to water, and in cases where the decks of the vessel are weak and liable to lift, a suitable buoyant compound, such as a mixture of paraffin and cork, is preferred. This can be readily pumped, it solidifies in water, and after being forced into the vessel it will, through its buoyancy, readily seek the under surface of the decks and the sides of the vessel, and becoming hard will form a light, solid body that will strengthen the deck. Twenty-one claims.

867,984. DREDGING APPARATUS. SIMON LAKE, BRIDGEPORT, CONN.

Abstract.—The invention comprises a submergible tube, having its lower end terminating in a casing forming a working chamber, with

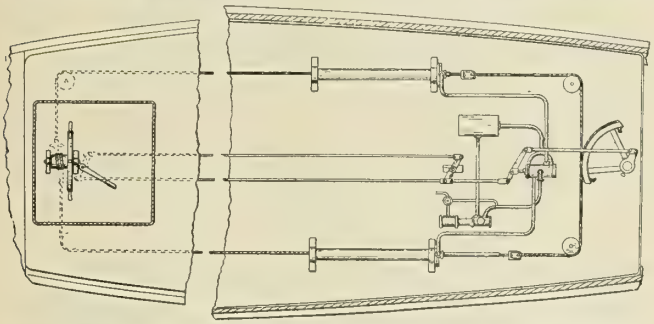


which is connected suction apparatus employed for collecting the gold, sand and gravel and delivering it into separating chambers, where the gold is separated from the sand and gravel, and the sand and gravel finally discharged back into the body of water. Supplemental means

are employed for assisting the suction apparatus in lifting the gold, sand, gravel and water. Means are employed within the working chamber, capable of being operated independently of the suction apparatus, for collecting the gold located in small crevices and in places where the larger pipes cannot work. Thirty-five claims.

868,160. HYDRAULIC STEERING APPARATUS. HART S. DE PUY, SEATTLE, WASH.

Claim.—1. In steering apparatus, the combination with the rudder post and a tiller line of a power cylinder, a piston within the cylinder,



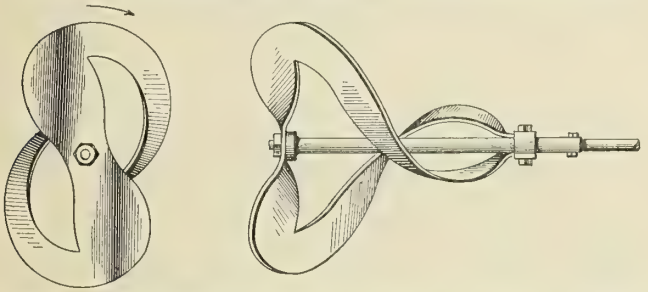
devices upon the said line whereby the line is operatively engaged by the piston when the latter is actuated by a power medium to move in one direction, and to engage the piston and move the same when the tiller line is moved in the opposite direction, and means to control the admission or escape of said power medium. Four claims.

868,199. PROPULSION OF BOATS OR VESSELS. JOHN H. LORIMER, PHILADELPHIA, PA.

Claim.—1. The means for propelling vessels by discharging under great pressure a large number of continuous fluid streams through narrow orifices arranged in series extending longitudinally of the vessel, the orifices in one series being in staggered relation to the orifices in the adjacent series, each stream discharging independently and without interference with the other streams, or the fluid of flotation under such other streams affected thereby, so as to utilize substantially all the velocity of the streams at the edges of the orifices. Two claims.

868,220. PROPELLER. JULIAN PORTELLI AND JOSEPH D. CHAPMAN, LOS ANGELES, CAL.

Claim.—1. A propeller comprising a shaft, a plate fixed at its longi-



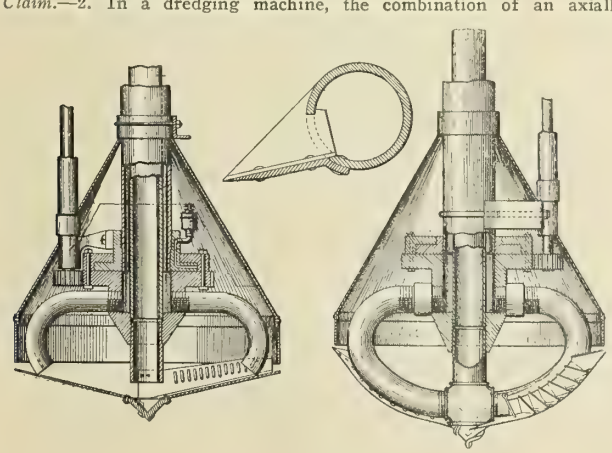
tudinal center to said shaft, said plate being bent laterally in opposite directions and having forwardly extending spiral wings, the ends of which are fastened to said shaft.—Three claims.

868,946. TORPEDO PROJECTING APPARATUS FOR SUBMARINE AND SUBMERSIBLE VESSELS. HENRI SMULDERS, SCHIEDAM, ROTTERDAM, NETHERLANDS.

Claim.—2. A torpedo projecting apparatus for submarine and submersible vessels, comprising a tube, three cylinders, piping adapted to form communication between the said cylinders, a supply of fluid under pressure adapted to communicate with the first cylinder, and an arresting device such that the piston of one cylinder releases the said arresting device as soon as the apparatus has been raised to the desired height by the piston of another cylinder, the piston of the third cylinder then producing the forward movement of the torpedo in the said tube, this forward movement having the result of opening the air supply valve and starting the movement of the torpedo. Two claims.

869,273. DREDGING APPARATUS. EDWARD B. STODDARD, CHICAGO, ILL.

Claim.—2. In a dredging machine, the combination of an axially-



disposed intake, one or more feeding arms arranged to rotate about said intake, means for rotating said arms, excavating blades for excavating material in advance of said arms, and means for directing water through said arms toward said intake. Seventeen claims.

869,130. YIELDING BOAT-CLEAT. FREDERICK A. BIERIE, PHILADELPHIA, PA.

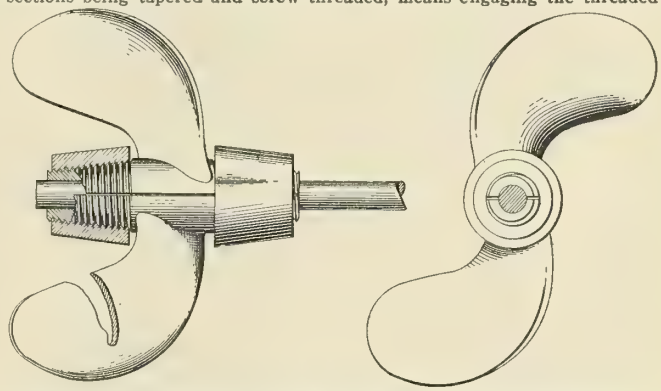
Claim.—1. A boat-cleat comprising a base, post and T-head, and yielding means arranged in the head, provided with rope-attaching means. Four claims.

869,399. ADJUSTABLE TOP FOR LAUNCHES. WALTER P. WALTER, STAMFORD, CONN.

Claim.—2. The combination with the combing of a launch, of a vertically movable top having a depending flange inclosing the combing in its lowered position, folding standards by which the top may be retained in the raised position, and offset supports on the combing by which the front standards are held against swinging forward, and the rear standards against swinging backward. Seven claims.

870,136. PROPELLER WHEEL. ROBERT W. SHAW, STAMFORD, CONN.

Claim.—2. A propeller comprising a sectional hub, the ends of said sections being tapered and screw threaded, means engaging the threaded



ends of the sections for clamping the same upon a shaft, and outwardly inclined blades disposed diagonally to the axis of the hub, each blade being concavo-convex in section. Two claims.

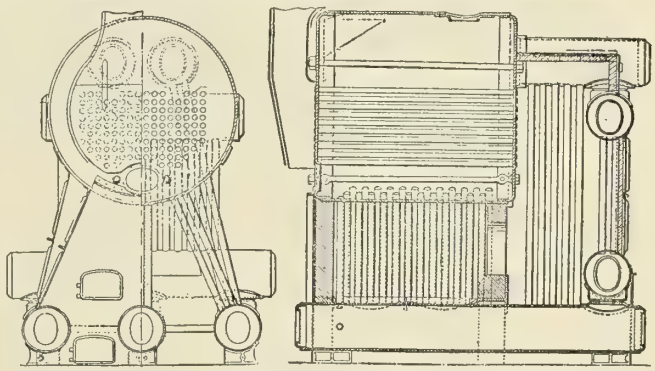
870,235. DEEP-WATER GOLD DREDGE. WARDELL GUTHRIE, CHICAGO, ILL.

Claim.—4. In a gold dredge, the combination with a float, of hydraulic dredging means adapted to be raised and lowered, hoisting mechanism arranged to act upon the said dredging means, a plurality of buckets, and hoisting devices and tackle arranged to raise and lower the said buckets adjacent to the said dredging means. Seven claims.

British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London, W. C.

10,111. STEAM GENERATORS. COMPOSITE BOILERS. L. TAYLOR, SALTBURNE-BY-THE-SEA.

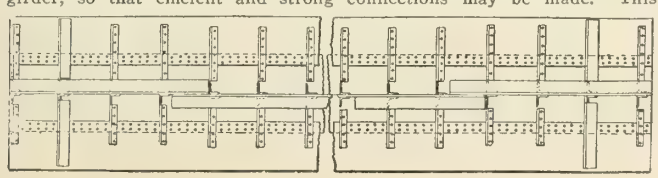
An upper steam and water drum, traversed by smoke tubes, is connected with water drums at the sides of the grate by two rows of tubes, which serve as uptake and downtake tubes respectively. There may be a central water drum connected by vertical tubes with the upper drum. The sides and back of the combustion chamber are also formed of



double rows of tubes, which communicate above with extensions of the drum, and below with the water drums; the tubes are connected to intermediate transverse drums. Two boilers may be placed back to back to form a double-ended boiler.

10,262. SHIPS' KEELSONS. R. E. ELLIS, OF D. & W. HENDERSON & CO., PARTICK, GLASGOW.

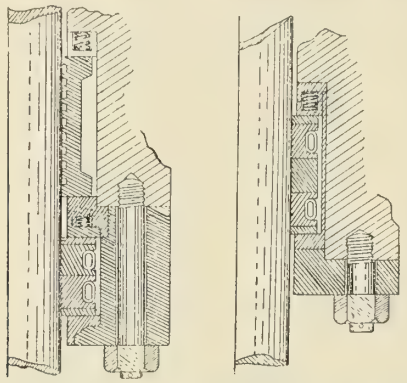
The center girder of double bottoms is constructed with its upper and lower edges either flanged or fitted with an angle bar. The angle bars or flanges are arranged on opposite sides of consecutive portions of the girder, so that efficient and strong connections may be made. This



construction enables the keelsons to be built up from templets, and to be riveted up before being put in place. In a modification, the flanges or angle bars are on the same side on consecutive plates, and the butts are strengthened by short angle bars.

10,023.—STUFFING BOXES. J. B. L. ROBSON, NEWCASTLE-UPON-TYNE.

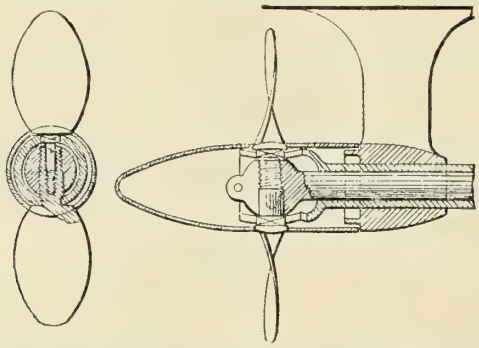
A packing ring is divided by tangential cuts into segments braced together by two springs, which lie each in a groove, and are secured to pins. There may be four springs, in which case each segment has pins. In some cases the ring has parallel grooves, each containing



springs. In one arrangement of this packing two rings with washers and a compound ring containing springs for axial adjustment are contained in a box, supplied with lubricant by a passage. The rod is further packed by a grooved sleeve adjusted axially by springs.

10,491. SCREW PROPELLERS. W. AND V. LORENC, BERLIN, GERMANY.

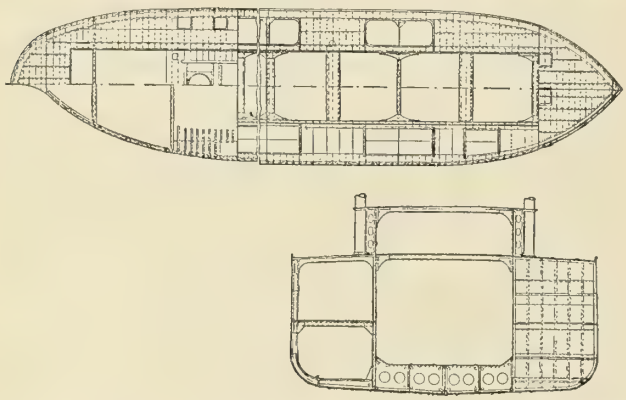
The blades of screw propellers are supported in pairs situated in the same plane. The shank of one blade is mounted in the shank of the opposite blade, which itself is mounted in the hub. By this method, the blade shanks may be made of great length without increasing the diameter of the boss. The blades are preferably secured by screwing



one into the other, and this method of construction is specially applicable to feathering screw propellers. The blades are feathered by sliding the boss longitudinally within the hollow shaft, which is provided with curved slots engaging with squared surfaces on the blade shanks.

11,078. SHIPS' BULKHEADS AND TANKS. J. H. ZEEMAN, THE HAGUE, HOLLAND.

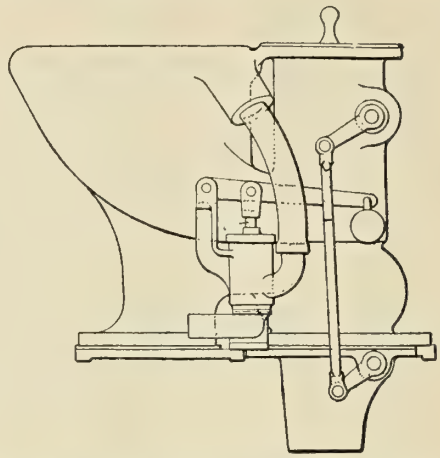
A ship is divided into three holds by two longitudinal bulkheads extending above the upper deck, and continuously from the forepeak



cross bulkhead to a stern cross bulkhead. Additional cross bulkheads may also be fitted.

11,526. SHIPS' CLOSETS. J. BROADFOOT & SONS AND J. R. APPLEBY, PARTICK, GLASGOW.

In closets of the type in which two valves are used, one being closed while the other is open, a handled rod is connected directly to the upper valve, and the spindles of the valves are connected by links. Through a slot in the vertical link passes a weighted lever pivoted to a



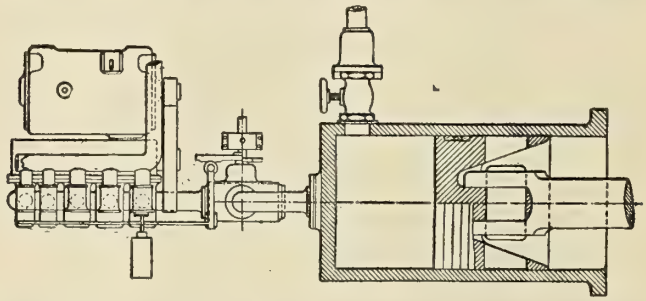
bracket and the spindle of the flushing valve. When, therefore, the upper valve is opened by raising the handle, the flushing valve is opened and a flush delivered. The flushing valve is not quite closed when the upper valve reaches its seat, so that an afterflush is delivered during the time that the weighted lever continues its descent.

12,151. SHIPS. J. CANARD, PARIS, FRANCE.

Vessels are constructed with an inner as well as an outer skin, and the space between the skins is filled with a number of cells containing air or other gas, or cork, pine-soot, or the like. A buoyant structure is thus formed. In addition, the cells may be fitted in all vacant spaces in the ship, such as between the planks or timbers of decks, bulkheads, and the like. The cells may be made of india rubber or metal.

12,335. STEERING GEAR. SIEMENS BROS. & CO., WESTMINSTER, LONDON, AND H. WRIGHT.

Two or more hydraulic rams, fed by a number of pumps, operate the tiller rods. The pumps may be put in or out of operation as the load varies during the movement of the rudder by a device for throwing their valves out of action, or by a by-pass. By this means, the motor driving the pumps may run continuously, but the invention is not confined to apparatus in which this occurs. The control valve for the hydraulic rams may be operated in the same way as an ordinary control



valve for a steering engine, being provided with a cam disk which lifts the suction valves of the pumps when it is at or near its mid position.

13,086. SHIPS' BULKHEAD DOORS. L. C. F. GUEMBEL.

Relates to apparatus for simultaneously opening and closing bulkhead doors hydraulically from a central station, the water under pressure led to the hydraulic cylinders for the different doors being regulated from a single reversing cock. The controlling mechanism for the individual doors, which allows them to be opened or closed locally, consists of a piston provided with waterways and capable of being reciprocated in a cylinder by means of a hand lever. The cock on the bridges is connected with a water-pressure reservoir and a waste-water tank, and with each separate door by pipes. A peg locks a hand lever and keeps the piston at the bottom of the cylinder. When the doors are opened from the bridge, and it is desired to close one door locally, the peg is removed, so that the piston is forced up, the pressure is reversed in the cylinder, and the door closes. When the lever is brought back to its former position, the door opens.

13,859. INDICATING POSITION OF SUNKEN SHIPS. H. SCHWAB, PARIS, FRANCE.

An inflatable buoy for indicating the position of sunken vessels, *e. g.*, submarine torpedo boats, is deflated, folded and placed within a chamber of a suitable vessel, which also contains a gas generator. Water passes into the latter, upon immersion, through a valve and acts upon carbide in a cylinder. The valve is gradually closed by the pressure exerted upon the perforated diaphragm, and the top of the buoy or balloon is forced along the tube until it lifts the end, when the buoy expands into the water, its lower end being rigidly attached to the tube. A relief valve is provided at the top of the buoy, and it may be combined with a whistle or siren and with a self-lighting burner.

14,016. BARGES; BULKHEAD DOORS. S. WATKINS, LONDON.

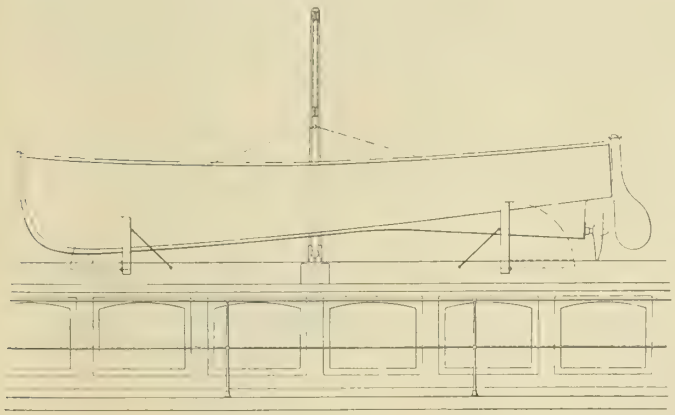
In lighters or vessels from which coal or other material is discharged by means of continuous conveyors through doors at opposite sides of a tunnel, a platform is provided in the tunnel so that a person may readily observe the discharge of the cargo, and easily operate either of the doors should it become blocked with a large piece of material. The doors are held against the sides of the tunnel by rollers, carried either on the doors or their frames. Each door is fitted with a vertical rack, with the teeth of which a bar may be engaged. Pivoted weighted pawls maintain the doors in the desired position, and the pins upon which the pawls turn are utilized as fulcrums for the bar.

ENGINEERING SPECIALTIES SUPPLEMENT

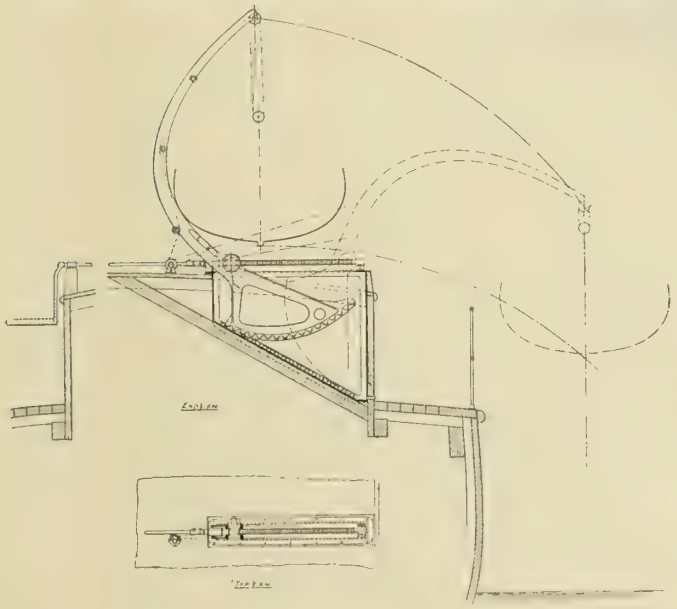
Information concerning some of the useful devices used in various capacities in shipyards and repair shops, and aboard ship.

The Welin Quadrant Davit.

We have previously made our readers acquainted with the characteristics and advantages of this system of boat launching gear. As a further illustration of the adaptability to the various modes of carrying boats on vessels of different types, we now give a diagram of the "M" style. This type has been



specially designed for use on good sized motor yachts, where it is the practice to carry a tender or rowing boat on the top of the trunk cabin. Ordinary davits are in such cases more or less unsatisfactory, as it is impracticable to give them a sufficient amount of overhang to lift the boat outboard, from its position in the chocks, to clear the side of the vessel. Moreover, such davits become unnecessarily heavy, and are difficult to handle if the vessel has the slightest rolling motion.

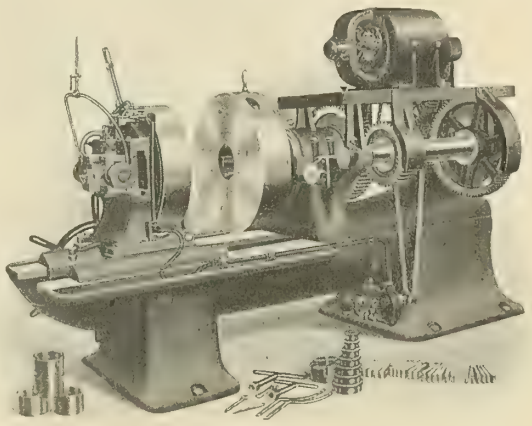


With a single davit of the type here illustrated, one man can, with perfect safety to the boat, swing it out across the deck clear of the rail in about thirty seconds. The davit head stands less than 5 feet above the crown of the cabin's roof. The frame, serving as a guide for the quadrant, projects a little inside the cabin, but only to a very small extent. When placed against a bulkhead this even is hardly noticeable. The frame has been provided with a casing of thin brass plate, to prevent any possible leakage. The whole apparatus is made of toughest manganese bronze, and can be had either plain or polished, in accordance with the purchaser's desire. It is placed on the market by Capt. A. P. Lundin, 17 Battery Place, New York.

A New Crane Pipe Machine.

This machine is one of the latest models, and embodies the most modern improvements in the manufacture of pipe cutting and threading machines. It is very substantially and compactly built, consisting practically of but three pieces. All working parts are so placed that strains come directly on top of the base. The motor is located on top of the machine, directly over the bed, where it can be best taken care of, be out of the operator's way and protected from chips. Of the quick-grip and sliding die head type, the machine was designed for use where rapid production is essential.

The gripping chuck is of a specially constructed type, so designed that any pipe may be either gripped or released by



moving a lever, without stopping the machine. It contains four jaws made of high grade steel, with eight removable roller contact teeth, which will grip (without slipping) pipe that is not perfectly round. These jaws are adjusted by an internal cam operated by a worm and gear. The rear end of the spindle contains an independent three-jaw chuck, used for centering or gripping long lengths of pipe. To facilitate the operation, removable bushings are supplied to fit in the spindle to guide pipe through the gripping chuck.

The die head is movable, and carries with it adjustable expanding dies in sets of six, pipe-centering guides, and patented air cutting-off attachment, operated by an air pressure device controlled by an air cock. The opening and closing of this cock governs the working of the two cutting-off tools. This is said to be the most efficient and satisfactory means yet invented for cutting off pipe. The dies are of high-speed steel, made extra long, and will cut threads for extra heavy flanges of fittings, and still maintain the exact taper on the threads. For threading pipe below 4-inch an extension die head is supplied, which should always be used, as it supports the dies and prevents them from bending. The dies may be removed from the head by taking off the cover, which immediately exposes all the dies.

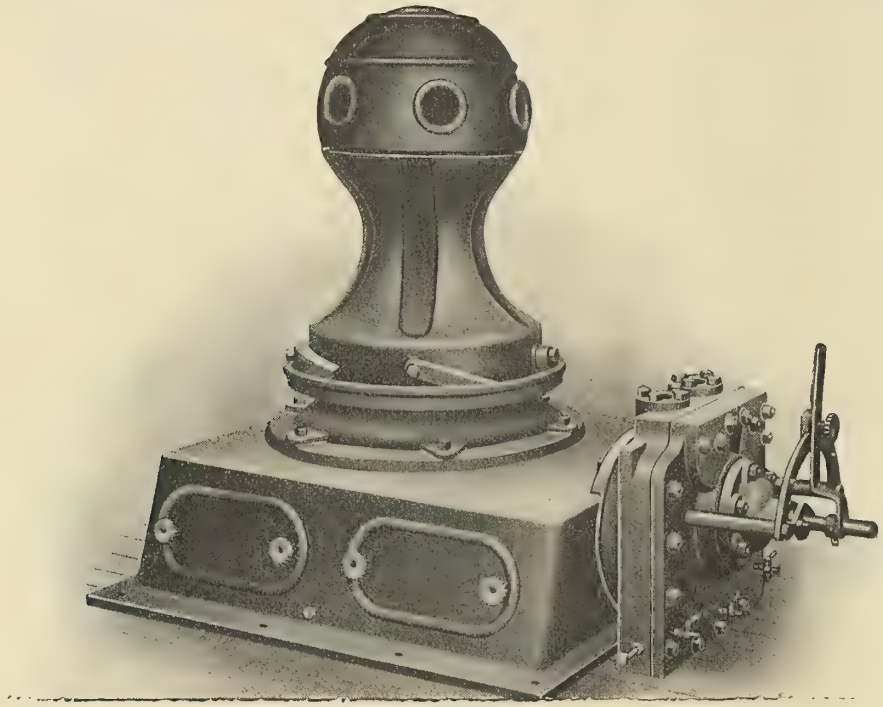
A rotary oil pump is supplied, and particular attention has

been given to the distribution of oil on the dies. The belted machine contains a three-step cone pulley, which, with back gears, gives sufficient change of speed for all sizes of pipe within the range of the machine. These machines are furnished for engine, belt or motor drive, the capacity being pipe from 2½ to 6 inches.

Dimensions: Countershaft pulley, 20 inches diameter by 6-inch face; countershaft speed, 125 revolutions per minute; weight, 9,000 pounds; floor space, 9 feet 6 inches by 4 feet 6 inches.

The Dake Steam Deck Capstan.

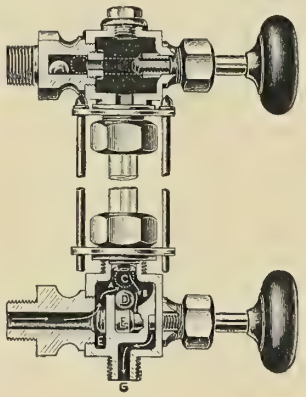
The Dake Engine Company, of Grand Haven, Mich., has brought out a new capstan which is extremely simple in construction, and is said to be unequaled for ease in handling and power, as well as compactness. It has no dead center, and is made for two pulling speeds, regulated by the throw of the reversing lever. The working parts being entirely inclosed overcomes all danger from dust or dirt. It can be simply placed on the deck and bolted down, steam and exhaust pipes connected and it is ready to work. They make only one size, fitted with an engine of 10 horsepower. The distance from deck to center of capstan head is 28 inches; size of steam pipe, 1¼ inches; size of exhaust pipe, 1½ inches; over-all dimensions of bed, 42½ by 45 inches.



An Automatic Water Gage.

Herewith we print a cut of what has the reputation of being a high-class automatic water gage. The "Success" has many good points, several of which are of vital importance to users of water gages. For instance, its automatic devices will not stick or become corroded. The automatic balls must go to seat when glass breaks. Blow-off is operated by gage handle and seats of valve can be reground. The objections to many automatic gages are that the automatic devices go to their seats on the sudden opening or closing of blow-off, or they become corroded, stick fast and do not operate at the critical moment. An examination of the "Success" gage will convince any engineer that these two objections are entirely overcome, as will be seen from the following explanation:

E is a double-seated valve to close both the gage and the blow-off. It will be seen, therefore, that every time the lower handle is turned to blow off the gage, the automatic device or ball *D* is moved by the stem on which it rests. In addition to this, the stem follows the course of the arrows *B* to the outlet *G*, creating a downward pressure on the ball *D*, and rolling it about in the chamber in which it is located. This great agitation of this ball from three to six times a day prevents it from ever becoming limed up and stuck fast. When the glass breaks, everything is reversed; the steam rushes upward to the break, creating a strong vacuum at the lower end of glass, when ball *D* is instantaneously raised to the location marked *C*, when flow of steam ceases. The upper ball is forced to its seat by pressure from boiler. The double seats of valve *E* can be ground by simply loosening the stuffing nut on handle.

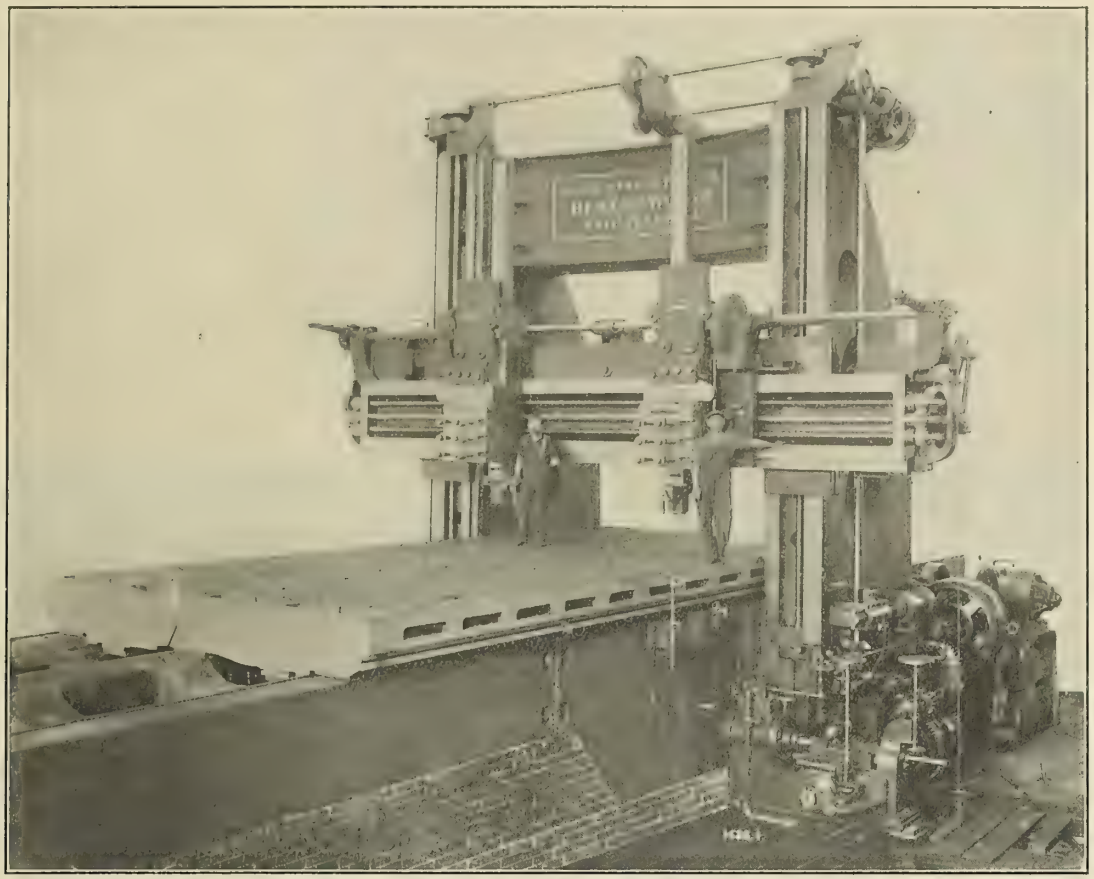


The Penberthy Injector Company, of Detroit, Mich., manufactures the "Success."

A Gigantic Planer.

Probably the largest and heaviest metal working planer ever built has recently been shipped from the Bement-Niles works (Philadelphia) of the Niles-Bement-Pond Company. The total weight of the machine is 845,000 pounds, or 422½ short tons. Four motors with a total capacity of 207½ horsepower are required to operate this remarkable tool.

The machine is, in general effect, an extremely large planer, but in addition to the movements found on a standard machine, many new ones have been added. Each head is fitted with a slotter bar, independently driven by rack, giving a cutting speed that is practically constant from one end of the stroke to the other, and a quick return. Through motor and change gears the cutting and return speeds can be changed as desired. Each head is arranged for transverse planing, having a planing movement across the bed which can be varied within desired limits, and having a quick return. The movements for slotting and transverse planing make it necessary to throw out the regular driving mechanism to the table and connect it to a separate feed motion, which, in this case, is entirely distinct from the regular feed motion. This throwing out of the driving mechanism, however, means simply that the

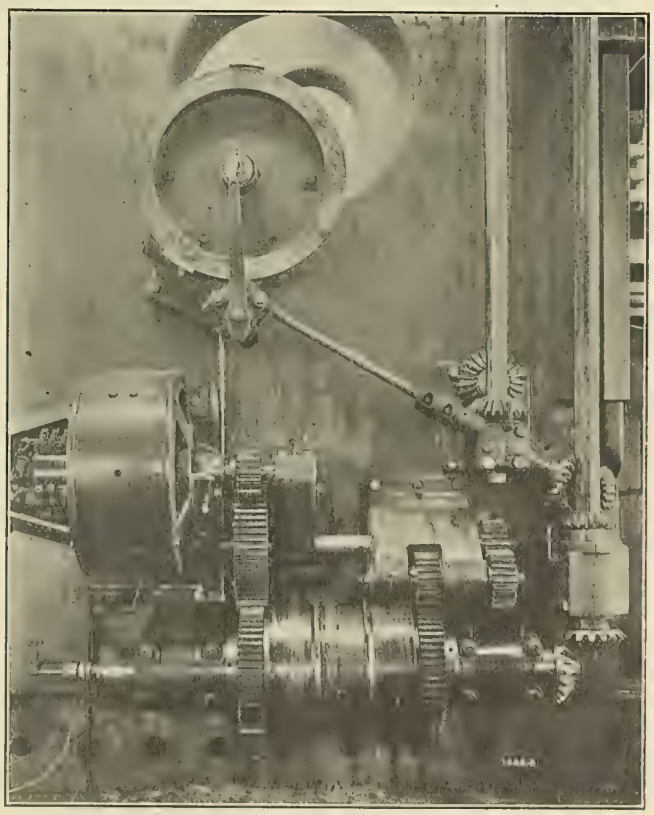


pneumatic driving clutches are thrown into and left in their idle position.

The machine is fitted with its own air compressor and motor, thus making it independent of the air supply in the shop, to which, however, it can be connected if it seems desirable. A complete switchboard is furnished for control of all the motors.

The distance between uprights is 14 feet 4 inches; the maximum distance from table to bottom of cross slide is 12 feet 2 inches; maximum stroke of table is 30 feet; maximum stroke of slotter bar is 8 feet; total width of bed 13 feet; length of bed 60 feet; table ways 15 inches each in width; tool slides 7 feet 8 inches, with 4 feet vertical traverse; cross rail is long enough to admit full traverse of either head between the posts; face of uprights 2 feet 6 inches; vertical height of cross slide, including the top rib bracing, is 5 feet.

The main driving motor is 100 horsepower; slotting and



cross-planing motor is 50 horsepower; lifting motor to cross slide 20 horsepower; traverse motor for heads on cross slide 7½ horsepower; air compressor motor 30 horsepower. The cutting and return speeds are variable through the motor, which has a 1 to 1¼ variation and further range by change gears. The cutting speeds are 14 to 25 feet and return speeds 52½ to 65½ feet per minute. The same style of drive is used for the slotter, and gives a cutting speed of 18½ to 30 feet, and return speed of 57 to 71 feet. Cutting speed for cross planing is 11½ to 19 feet, and return speed 35 to 43½ feet. The cross traverse speed to the heads is 50 inches per minute; the vertical speed for raising and lowering cross slide is 26 inches per minute.

The main drive from the 100-horsepower motor is through the gearing to the pneumatic reversing clutches at the base of the upright. The speed of these clutches can be varied to some extent by changing the speed of the motor, and a great variation obtained by the simple reversal of two change gears. The pneumatic clutches are of the N-B-P type, with a large number of friction disks, whereby great friction area is obtained in a comparatively small compass. These clutches, as their name implies, are operated by compressed air. A small valve, easily moved by hand, controls the stopping, starting and reversal of table, and handles satisfactorily the power given out by the large driving motor. In the handling of this amount of power in a motor-driven planer, it is unnecessary to state that it would be quite impracticable if a belt-drive were employed. From this point on to the rack the drive is, in practically every respect, that which is found on any planer, except that in this instance it is exceptionally heavy and powerful.

Among the many other new features, not the least is the pneumatic feed for the cross heads. On the side of the upright, just above the gearing, is a cylinder with piston rod extending to the left. This rod carries a rack which meshes into a gear near the bottom of the vertical feed shaft. This shaft has, on its lower end, a bevel gear meshing into another bevel gear on a horizontal shaft, which transmits motion to the vertical feed shaft on the left-hand upright. The movement of these feed shafts is constant at all times, and variation in amount and direction of head feeds is obtained by adjusting the connecting rod in the slotted cranks on the ends of the cross-slide. These cranks are graduated in such a way that definite cross and vertical feeds can be obtained, and by using at the same time the cranks on both sides, an angular feed can be given to the tool, which is at times desirable, as the whole heads were not designed to swivel. The valve for controlling the air to the feed cylinder is thrown automatically at each end of the stroke, this movement being taken from either the main driving gear train to the table or the slotting gearing when slotting is being done. To throw out the feed it is simply necessary to close a valve, cutting off the air supply.

Owing to the great weight and large dimensions, it was impracticable, both from the manufacturing and the shipping standpoint, to make the bed or table in one piece. They were, therefore, divided to bring them within reasonable limits. The central section of the bed is divided longitudinally into three parts, and the two end sections into two parts each, or seven parts in all. The total weight of the bed is about 275,000 pounds. The table is made in two sections, divided longitudinally in the center, and weighs about 140,000 pounds.

THE POLISHING ROOM—DELAWARE MARINE SUPPLY MANUFACTURING COMPANY—THE ASSEMBLING ROOM.

The Delaware Marine Supply Manufacturing Company.

This company was established in March, 1902, and commenced business in October of the same year, in Wilmington, Del., in a very modest way; but the demand for goods has kept increasing, so that in the course of its five years of existence its capacity has grown to about five times its original size. While this, in itself, indicates a healthy growth, it has to be further noted that the line of manufacturing here undertaken is one which requires great skill in execution, for the reason that a high grade finished article has to be produced at a marketable price with a profit, therefore necessarily requiring a low factory cost, which can be accomplished only by specially designed labor-saving tools, a pointed system, well trained working force and factory economy. The line of goods is of a varied nature and includes ship airports in all designs, cast brass and bronze hinges, screw work, ship and boat fittings; car hardwares, such as parcel racks, sockets, catches, etc., and general marine hardware; all these articles being manufactured in cast brass or bronze from the ingot to the finished product.

The work is distributed through the shop in classified manner, so that each group of workmen is trained for one of these classes, and perfection is obtained through subsequent handling of the same kind of work. Most of the work is done on the piece-work plan, and a rigid inspection through

THE MACHINE SHOP.

all the stages of completion prevents the slighting of the work. No secrecy is kept as to the ruling wages, the best producer receiving the highest pay and most consideration; and promotion to higher positions is done as much as possible among the most deserving of the old hands.

The plant consists of the following departments: (1) Brass foundry and cleaning room; (2) machine shop; (3) polishing shop; (4) plating shop; (5) lacquering shop; (6) assembling shop. Besides this there are a drafting department, pattern shop and a well-equipped tool shop, where all special tools are made. A storeroom and stockroom also furnishes part of the equipment.

The laying out of the plant is so adjusted that the different departments adjoin each other in such a manner that the least time is lost in handling and transportation. This is a very important factor, especially for the hardware line, as these articles have to undergo a great many operations before completion. Thus, a small piece of hardware has to travel through foundry to cleaning room, dipping room to storeroom, where inspection of castings are made; from there it is passed to machine shop, polishing room, lacquering room, assembly room, and then finally to packing room, where the last inspection and packing are done.

New High-Speed Motor Boats.

The Electric Launch Company, of Bayonne, N. J., has just shipped two high speed *Elco* express boats to G. & O. Braniff & Co., of Viguetas de Acero Belga, Mexico. The photograph illustrates one of the boats, which were 40 feet in length, 5 feet 6 inches beam, and 2 feet draft. Hulls are of substantial, but light, construction, oak frame, cedar planking, copper fastened throughout. Decks and interior are handsomely finished in mahogany. The power equipment consists of a four-cylinder 6 by 6-inch gasoline marine engine with mechanical reversing gear, Tobin bronze propeller shaft and bronze propeller wheel. The builders guaranteed a speed of 19 miles an hour, which in each boat was exceeded, the tests being carried out during very rough weather on New York bay over a measured mile course, an average of six runs being taken. The *Chapala*, one of the boats, exceeded a speed of 19.6 miles per hour.

The motor is located forward of the operator's cockpit under a metal hood, with control reverse brought out on

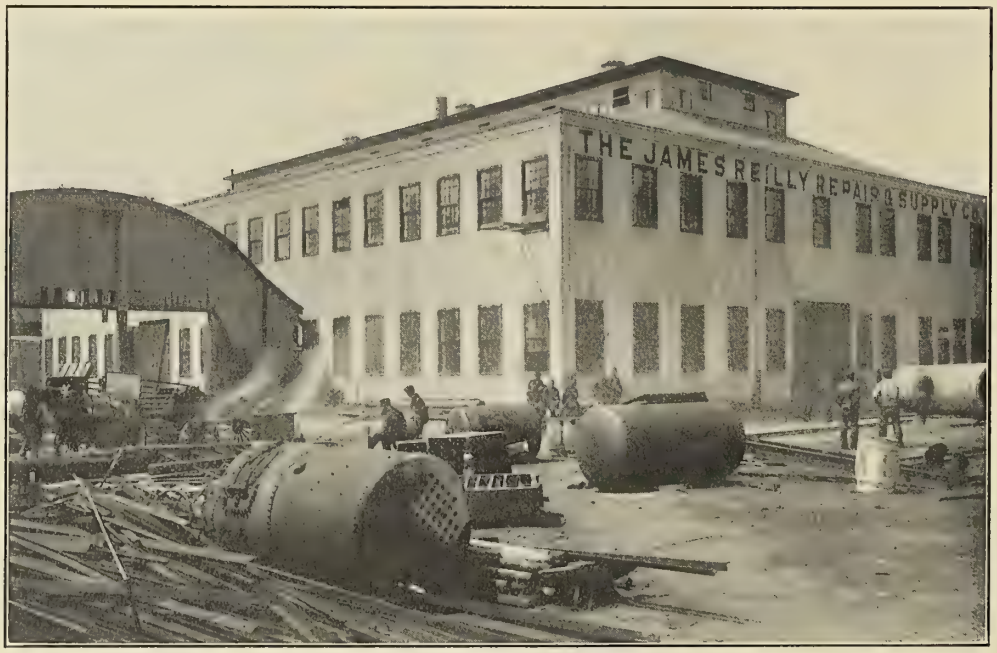
bulkhead alongside of steering wheel. The fittings and furnishings of the boat are very complete, including cushions, wicker chairs, cape-cart folding automobile hood, acetylene searchlight, glass wind shield, etc.

These boats closely resemble other types of *Elco* express boats, of which the company has made a specialty during the past few years, and which have proved very successful in the hands of their customers. The boats are not racing machines, but serviceable high-speed pleasure boats which, it is claimed, will serve one on water as the automobile does on land.

INTERIOR OF THE JERSEY CITY SHOP OF THE GRISCOM-SPENCER COMPANY.

The Griscom-Spencer Company.

The Griscom-Spencer Company is the direct successor of the old James Reilly Repair & Supply Company, established some forty years ago, and which for many years provided all the repairs and supplies for the ships of the International Navigation Company (American and Red Star lines). Their New York shops and pier in Jersey City, adjoining the terminal of the Pennsylvania Railroad, have recently been rebuilt and equipped with all modern facilities for handling steamship repairs and installations with the greatest economy and efficiency. Their location is especially convenient, being just opposite the lower end of Manhattan Island, and close to all the principal ferries. Being so centrally situated, repair gangs are sent readily and quickly to any vessel requiring their services, wherever she may be lying in New York harbor.



EXTERIOR VIEW OF THE JERSEY CITY REPAIR SHOPS.

GENERAL VIEW OF THE WHARFAGE AT JERSEY CITY, SHOWING NUMEROUS VESSELS UNDER REPAIR.

The Philadelphia shops, at the foot of Washington avenue, are equally convenient to vessels lying in the Delaware river.

In the matter of ship supplies, the company is probably the largest in the United States, and is the only concern equipped to do both a repair and supply business on so large a scale.

The Jersey City yard, which we illustrated at page 403 in October, 1906, has two Pennsylvania Railroad switches, one at Grand street and one at Sussex street, making it convenient to load and unload machinery and supplies. A small industrial track runs all around the building to facilitate the handling of heavy material. Duplicate air compressors are installed and air and water pipes conducted down to the end of the mooring pier.

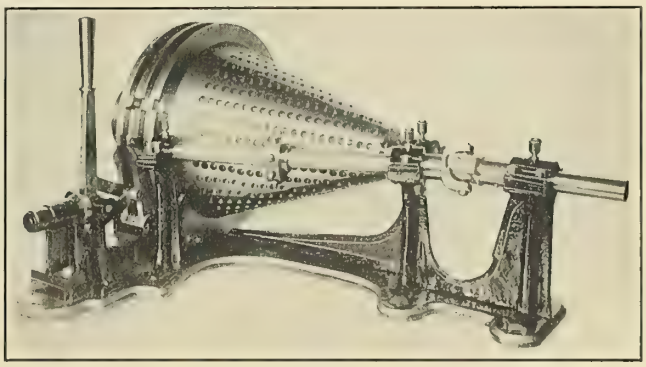
The supply building on West street is one of the most modern structures of the kind in the city of New York. It has been especially built and equipped for the purpose of conducting a ship chandlery, hardware and contractors' supply business. It is six stories high, with inside measurement of 50 by 110 feet, and has two electric elevators. The general offices are in the new West street building, New York.

The R-W Speed Variator.

This device, placed on the market by the R-W Speed Variator Company, Singer building, New York, for deriving variable speeds from a constant-speed motor, differs in a number of important respects from all prior devices for a similar purpose, and by virtue of its novel features the device is said to possess marked durability, efficiency, simplicity and ease of control. Fundamentally, the device is based on the gear-and-cone principle, but utilizes this principle in a new and strikingly ingenious way. It is especially applicable to motor boats.

As will be seen in the figure, the gear cone is provided with a number of circumferential rows of gear pits, and parallel with the slant of the cone is a shaft on which is feathered a spur gear having pin teeth of a general conoidal form. This gear is adjustable longitudinally on its shaft, so as to be brought into mesh with any desired row of gear pits on the cone, thereby causing the driven element, which, of course, may be either the gear or the cone, to rotate at a corresponding speed.

From mathematical considerations, deducible from the geometric properties of a cone, if the number of pits in the successive rows differs in arithmetical progression, the rows themselves must be equidistant from each other. Hence the



gear can be shifted by equal steps from either end of the cone to the other and be in mesh with a row of pits at each and every step. Furthermore, the rows can be so arranged that one pit of each row will lie in (or, strictly speaking, will be bisected by) the same axial plane. Stated otherwise, this means that the circular rows can be arranged so that one pit of each row will be exactly in line with the correspondingly located pits on all the other rows. This straight or longitudinal series of pits is formed on a sliding bar capable of movement in both directions a distance equal to the space between successive circular rows of pits. It will thus be seen that if, at the instant in the cone's rotation when the

slide is parallel with the gear shaft, the slide is shifted, it will carry the gear to the next row of pits.

At the base of the cone are two grooves, which the slide crosses, and projecting from the slide into the grooves are two studs, the arrangement and proportioning of the parts being such that the studs, when the slide is in its normal position, are spaced slightly from the rib between the grooves. Adjacent to the grooves are two oppositely inclined cams, each equal in width to the distance which the slide must move to transfer the gear from one row of pits to the next, so that the cams, engaging the stud on the slide, will shift the slide the proper distance. The cams are mounted on the upper ends of two arms pivoted at their lower ends. For the purpose of actuating the arms they are connected by links to a controlling lever on opposite sides of the pivot of the latter. This method of connecting the cam-arms with the controller makes it impossible to throw both cams into the grooves at once.

To restore the slide to its normal position after each actuation, an inclined member is provided at each side of the flanges at the base of the cone, against one or the other of which one of the slide lugs strikes after passing the gear. Thus if the slide has been moved toward the base of the cone, the end of the slide projecting beyond the flange will engage the adjacent inclined member and will thereby be thrown to the normal position. It will be seen that as long as one of the cams is held in its grooves, each revolution of the cone will produce an actuation of the slide and a corresponding shifting of the gear, so that the latter will move step by step up or down the cone, according to which cam is in operation. Arriving at the end of its shaft, the gear can, of course, go no further in that direction, and the cam must be retracted before the succeeding revolution of the cone brings the slide again into position for actuation. This retraction of the cam is effected automatically by mechanism inside the cone, which acts to throw the cam out of its groove, against the force exerted by the operator, just before the slide-lugs reach the position of the cam.

Mills Engaging and Disengaging Gear.

Of the many engaging and disengaging gears which have of late been placed on the market, the Mills may be safely said to have well proved itself. The reason of this is chiefly its simplicity and reliability in all kinds of weather and conditions, not only in regard to the detaching, but also to the attaching of the boat, which operation is often found quite difficult in a heavy seaway. This gear is especially sure and safe in the hooking on, and absolutely cannot jam the hands or fingers of the men, for the reason that an eye instead of a hook is used, and the block is handled entirely from the opposite end to the eye—in fact, the weight of the block alone hooks it on, with no danger to the operator.

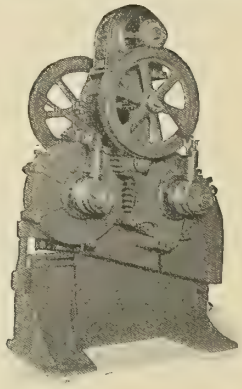
It has, in the last four or five years, been subjected to the severest tests, and is at present used by about two hundred and fifty steamship lines, plying to all parts of the world. It is also extensively used in cable ships and pilot boats. Most seafaring people know that the two last mentioned have much more real boat work in the open seas, under all weather conditions, than any other service. The only drawback of the gear, with regard to its adaptability to the average lifeboat carried on American passenger vessels, is that it costs somewhat more to install in old life boats than some of the other hooks on the market. Yet all those who have so far made use of this gear in such instances have expressed themselves as well repaid for the extra outlay, feeling they have made use of the best possible appliance.

When building new lifeboats it can be installed as easily and as economically as any other, and therefore it would be worth while for ship owners and boat builders to consider the adoption of this apparatus when laying down the plans of the lifeboats. It is handled by Capt. A. P. Lundin, 17 Battery Place, New York.

Universal Angle and Plate Shear.

The illustration represents a new universal plate splitting shear manufactured by A. F. Bartlett & Company, Saginaw, Mich., for cutting plates, bars and angles of even and uneven legs, also small channels, by making extra shear-knives. The designer has found this shear a valuable tool for all boiler makers and metal workers.

The square opening on the side is the angle shear, which cuts angles of even and uneven legs to any angle up to 45 degrees. Both shears are driven from one pulley, the angle shear running in a 45-degree angle, and can be operated singly or both at one time. The clutch stops only at highest point. The clutch lever is universal, and can be turned to any side, to suit the operator. Cutting uneven legs of angle iron has always been difficult to accomplish, and necessitated large, special machines for the work, which were too costly for small manufacturers. This universal combination shear embodies all the best features of the double angle-iron shears, besides being a plate and bar shear which can readily be changed into a



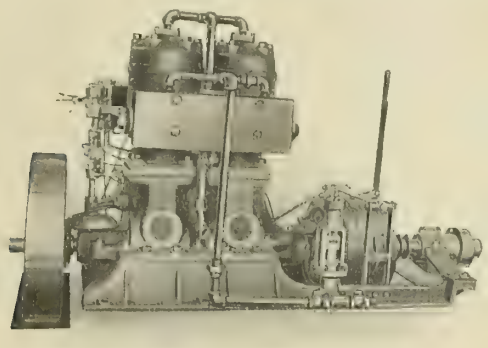
punch. It has proved a great labor-saving tool. Bars can be cut on either shear, and an extra shear for small channels can be inserted on either side. The machine has been designed to save floor space, and is very strongly geared.

A Two-Cycle Marine Engine.

The Termaat & Monahan marine engines, built in Oshkosh, Wis., are all of the two-port, two-cycle type, and are designed to eliminate the reversing propeller and reverse clutch. Four years' experience have demonstrated that the reversible engine is thoroughly practicable, and considerably more simple than any system of reversing gears. The Termaat & Monahan engines of double cylinder and above are started in either direction by the spark, or reversed while in motion; no cranks for starting are furnished, therefore danger of personal accident

is avoided. The fly-wheel rim is turned smooth in the form of a hand-wheel, so the engine can be turned around slowly when desired by the rim of the wheel. Friction clutches can be furnished for throwing off the load for starting or reversing, or a reversing clutch can be attached.

All of the Termaat & Monahan engines are said to give a good margin in power and are not overrated, the cylinders are large for the rated power, the crank shafts are extra heavy and the bearings are long. The oiling system is a point that must not be overlooked; oil is led to all bearings, the crank pins receiving oil as positively as other parts through oil

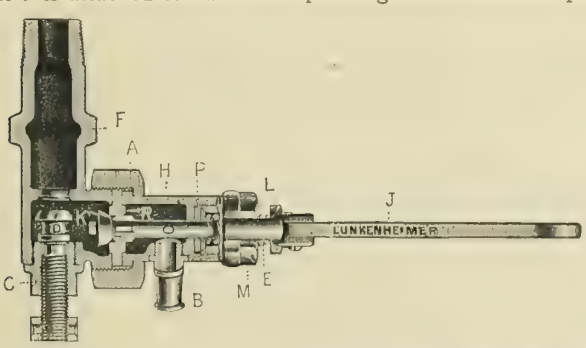


rings secured to the sides of the cranks, in which the oil drops and is carried through the crank pin to the bearing, which is all important for long and continuous service. The exhaust outlets are large, and provide for quick expulsion of the burnt products, so that no back pressure is produced at high speed, and under-water exhaust can be used with beneficial results.

The Termaat & Monahan 8-horsepower engine is used in launches from 20 to 24 feet, and the 12-horsepower in 22 and 32-foot launches, showing speeds of from 11 to 14 miles per hour. These are the two popular sizes at the present time, and are double-cylinder self-starting and reversing. Termaat & Monahan speed propellers are used on all Termaat & Monahan engines. These propellers are of very fast model, and in some cases show only 7 percent slippage. The Termaat & Monahan engines are arranged to use kerosene where gasoline is not obtainable.

An Improved Gage Cock.

The gage cock shown herewith is known by the trade name of "Excelsior," and is manufactured by the Lunkenheimer Company, Cincinnati, Ohio. The cock is made in two parts, held together by the union ring *A*. That part to which the lever *J* is attached contains the operating mechanism and parts



most liable to wear. The other part of the gage cock is screwed into the water column, and contains an emergency valve, which is easily opened or closed by means of a wrench applied to the nut *D*. The object of this emergency valve is to make it possible to remove the part containing the operating mechanism, while pressure is on. It will, therefore, be seen that, should accident happen to the cock, or should it be found necessary to clean the same while pressure is on, it can readily be accomplished by simply closing the valve *D*.

Another important feature in the construction of the gage cock is the renewable, reversible seat *R*, which aids in making a very durable construction. The lever *J* is adjustable, and can be turned to any desired position. A rope or chain can be attached to it should the same be beyond reach from the floor. The spring *M* will last indefinitely, owing to the fact that there is no possibility of its becoming limed up, or losing its tension. This is due to the fact that it is not in the least exposed to the escaping steam or water.

Corrosion of Marine Boilers.

Many and various have been the explanations offered for the phenomena of internal corrosion in marine boilers, and perhaps the present article may help to throw some light upon the subject by presenting the now generally accepted facts in brief form, and untangling some of the confusion arising from the multitude of conflicting statements and observations. Professor Vivian B. Lewes—a recognized authority on the subject of marine boiler deterioration—states that in the presence of moisture, carbonic acid and oxygen simultaneously attack iron and steel, forming a thin layer of carbonate of iron. This is a very unstable salt, which almost immediately breaks down into iron oxide and ferric hydrate, liberating the carbonic acid, which, with a further supply of atmospheric oxygen, continues the process of corrosion or rusting. This process is further hastened by a certain degree of electrolytic activity between the iron and the electronegative hydrated iron oxide. Inasmuch as the layer of oxide or, as we commonly know it, rust, is highly porous, the action progresses without interruption as long as the conditions are favorable. The above general conditions obtain when any iron or steel is exposed to the action of oxygen, carbonic acid and moisture.

Internal corrosion is due chiefly to the presence in the feed water of some oxidizing agent such as air, carbonic acid gas, free acids or dissolved salts which have the property of eating iron and steel. Often the internal corrosion is the result of the presence of free fatty acids liberated by the decomposition of greases or oils, containing animal or vegetable fats, or oils introduced by lubrication and brought into circulation by the surface condensers now in general use. The rational remedy for this effect is to use no lubricants for steam-swept surfaces except pure mineral oils, which cannot decompose into acids.

Perhaps the most common cause of internal corrosion is the dissociation of magnesium chloride (of which common sea water contains about 245 grains to the gallon) into hydrochloric acid and magnesia. The acid attacks the iron with great rapidity, forming a chloride of iron, which, as soon as formed, is dissociated in its turn by the free magnesia, producing oxide of iron (plain rust, black or red) and hiding its own action by reverting to chloride of magnesium—the salt which started the trouble. It appears, therefore, that no hope may be found for this trouble in the exhaustion of the injurious reagent by the formation of insoluble salts, but that on the contrary the corrosion must continue indefinitely, unless specific means are employed to neutralize the acid elements or link them with other mineral bases for which they have a stronger affinity than for iron. If, therefore, carbonate of lime is introduced into a boiler, its carbonic acid will unite with the magnesium base of magnesium chloride, forming the highly insoluble magnesium carbonate, while the hydrochloric acid of magnesium chloride combines with the lime base and forms highly stable and perfectly harmless chloride of lime. It is perhaps not amiss to add for those

readers who are not familiar with chemistry that the chloride of lime above referred to is not the "chloride of lime" of general household use, the latter containing an excess of chlorine gas by virtue of which it is useful as a disinfectant.

Electrolysis is a third form of internal boiler corrosion. An electric battery might be made up of almost any two elements or metals we could separate in an acid or alkaline bath of electrolyte. Theoretically such is certainly the case, and the amount and potential of the current obtainable would vary with each different combination of metals, some elements being strongly "electro-positive" and some strongly "electro-negative." The commercial battery, with its zinc and carbon elements and its sal ammoniac electrolyte, gives a high output for a low first cost and maintenance, and as such has established its usefulness. With its brass and copper fittings and connections, steel shell and tubes, and slightly acid or slightly alkaline water for electrolyte, a marine boiler may be regarded as a great electric cell, the iron and steel forming the negative electrodes, and the brass and iron the positive. The degree of electric activity—the output, as it were—depends chiefly upon the strength of acidity or alkalinity in the water. For every ampere of current thus developed, a fixed amount of the positive electrode—the iron—is eaten away, just as the zinc sticks are consumed in a common electric bell battery. How far the corrosive effects of magnesium chloride and the carbonic acid-oxygen combination contribute to hasten electrolysis, and how far electrolytic action promotes "rusting," have never been and probably never will be determined. Undoubtedly there are complex inter-relations and reactions of which we realize little, which, if better understood, might help to explain the extraordinary individual phenomena of pitting, grooving, honeycombing and other distinct forms of corrosion, but, in the present state of our knowledge, we can only classify these

FIG. 1.

FIG. 2.

as various manifestations of the same general causes, producing different results from reasons unknown. Figure 1 is a typical case of electrolytic corrosion of a plate cut from an old main discharge pipe on a P. & O. steamer.

"Cold iron" corrosion, so called, is a familiar cause of deterioration in laid-up boilers. The remedy for this is to remove any one of the three essential accompaniments of rust, carbonic acid, oxygen or moisture. The boiler may be emptied and thoroughly dried, or may be filled up completely and low fires maintained long enough to expel all air from the water, after which all connections should be closed tightly. It is *partial* filling that is responsible for cold iron corrosion.

One is hardly justified in explaining at length the ultimate effects of corrosion of plates, tubes, stays, braces, furnaces and pipes. If corrosion has advanced far enough to weaken any part, the possible damage is limited only by the complete destruction of the vessel by explosion and the death of all on board. The most terrible phase of the subject is that all too often corrosion proceeds to the danger point in out-of-the-way corners, unseen and undetected by even the most vigilant inspection. With the ever-increasing pressures now carried in marine boilers, the necessity, always great, for adopting every possible measure to guard against corrosion is doubly urgent.

"Grooving" is a peculiar form of boiler corrosion, usually occurring near seams or at bends and knuckles. The plate becomes deeply grooved or scored, probably as a result of surface cracks, undue calking of the seams, of expansion and contraction strains, all exaggerated by acid corrosion.

A form of corrosion know as "honeycombing" is illustrated by Fig. 2—part of a plate cut from an exploded boiler. The plate was originally ½ inch thick, but was corroded to a depth of ⅜ inch, the holes appearing as if drilled.

Pitting, unlike general corrosion, is marked by sharply defined edges, resulting in holes and patches of from ¼ inch to 6 inches or more in diameter, the depth of the pit varying

FIG. 3.

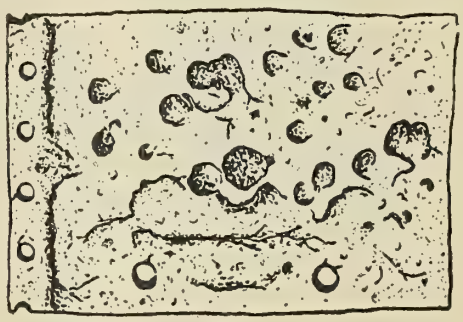


FIG. 4.

from 1/32 to ¼ inch or more. Such pitting is shown in the case of a tube in Fig. 3, and of a plate in Fig. 4.

Many and various have been the attempts to devise a cure for corrosion, but in nearly every instance such curative means have followed the plan not unlike the dentist's method of scraping out the decayed area of a bad tooth and filling the cavity. This plan is but a makeshift for a boiler, and the various cements and compounds applied to pits and corroded areas are but temporary reliefs in the *discovered* spots, and afford absolutely no protection against corrosion in other places. Neutralizing the acidity of the feed water will help considerably, but it has too often happened that the chemicals used to this end, and particularly the nostrums sold by boiler compound makers as removers of scale and grease, have wrought a havoc of their own on the plates and tubes far worse than the natural enemies they sought to repel. Zinc in slabs is extensively used in the effort to divert the electrolytic action from the iron to the more electro-positive zinc, and while much good has been accomplished by this method, it is but an incomplete remedy and a very expensive one.

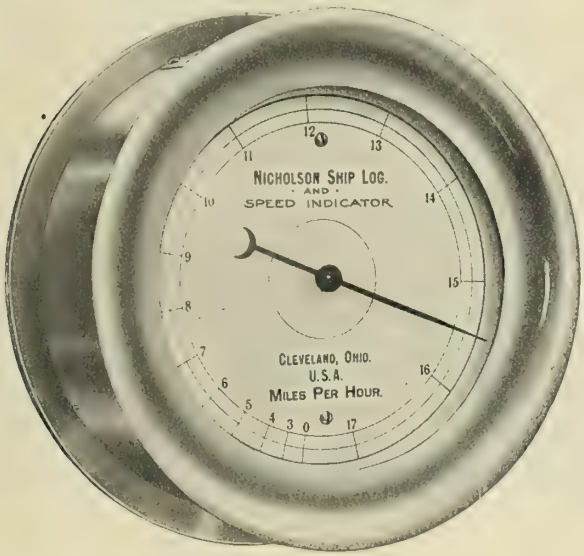
The only complete remedy for corrosion is to coat the interior of the boiler with a strongly adhesive, elastic, continuous layer of non-corrodible material. This must be very thin so as not to interfere with the transmission of heat, and of high conductivity, and it should be *metallic* in nature in order to become part and parcel of the surface of the iron it is supposed to protect. This conclusion is the result of observation of successful results of a boiler compound in which mercurial salts enter into composition, the action of which, when subjected to high heat in a boiler under steam, is to deposit a dark lustrous enamel-like coating over the entire wetted surface of the boiler and its tubes. That the composition as introduced with the feed water contains the necessary corrective elements to neutralize acidity and precipitate the harmful elements of the feed water is to be assumed as a matter of course, leaving the amalgam coating to envelop the exposed surfaces and areas and prevent corrosion.

It is, of course, evident that the writer has in mind a

definite product—the composition of the Bird-Archer Company, of New York. The only living ex-president of the United States, who has immortalized some famous phrases, not long ago said in effect that a successful political party should be one for the "enunciation of principles, not the denunciation of conditions." And so it should be in all things. It is well that we should understand causes and effects, but of greater importance even that we should understand remedies, if there be any. GEORGE P. HUTCHINS.

A Motor Boat Speed Indicator.

The Nicholson Ship Log Company, Cleveland, Ohio, has recently put on the market a motor boat speed indicator. This instrument is designed to show the speed at the moment, through the water, of motor boats and yachts. The principle of operating this instrument is the same as used for the well-known Nicholson log. The sea connection is a ⅜-inch brass pipe, projecting through a ¾-inch sea cock, about



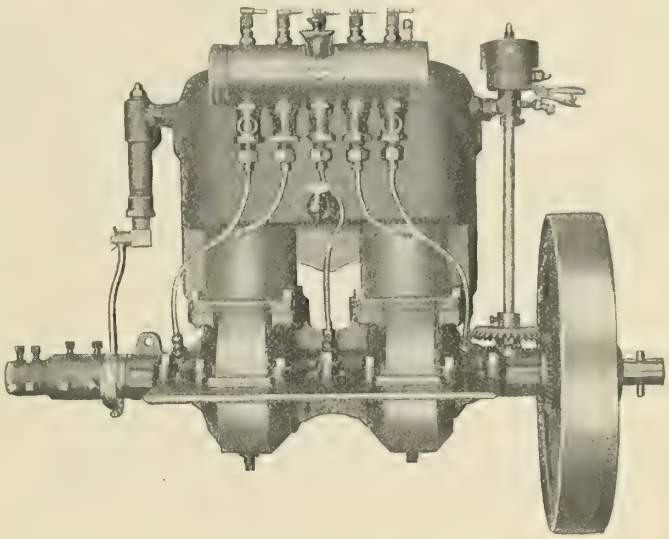
½ inch through the shell of the boat. This pipe acts as a scoop which forces the water into a float pipe, causing the float to rise and operate the instrument, a hand on the dial pointing to the speed the boat is making. It is an instrument that will interest all owners of motor boats, sailing yachts and small steam yachts. It can be placed in the cockpit or cabin of any motor boat or yacht.

Kowalsky Two-Cycle Gasoline Engines.

In order to gain its present footing as a motive power for marine craft, the gasoline engine has necessarily undergone many changes and improvements. Simplicity of construction and operation; economy; reliability, great power for size and weight; all these have been demanded by buyers, and have been realized by the different makers in varying degrees. The Kowalsky Engine Company, of Detroit, Mich., has met success during the past season, and the results of the Pittsburg Launch Club races on Aug. 3 made an excellent showing. On that occasion, with a large number of entries, two out of six events were won by boats containing these engines, and a third victory was apparently certain until the leading launch—Kowalsky driven—was run into by another boat and capsized.

Their 1908 model, a cut of which we show, is distinctive in many respects; the cylinder, cylinder head and water jacket are cast in one piece, thus avoiding that leakage of circulating water into the cylinder, which is so often a source of trouble. Another interesting feature is the rotary timer and secondary distributor, by means of which one coil may be used for both cylinders, thus insuring regular timing of the explosions. A slight change in the wiring, however, allows the use of a separate coil for each cylinder if desired.

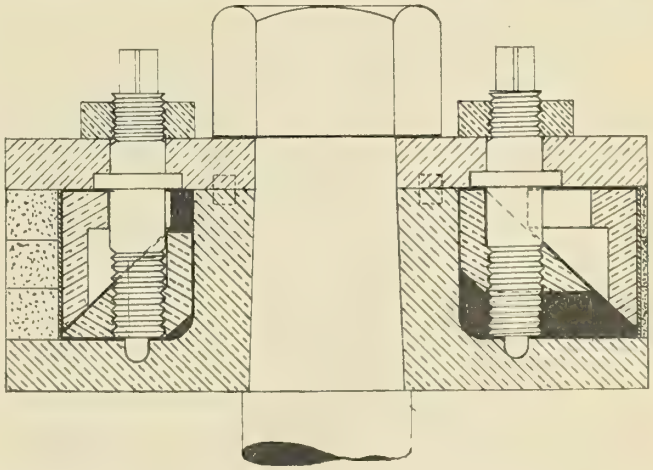
Simplicity of construction and operation, together with maximum power, is secured through the two-cycle design, while



every helpful feature has been adopted to insure long life and reliable, economical operation. Some of these are the long bearings, hardened pins, drop-forged crank shaft, bronze connecting rods, throttling governor, automatic lubrication, jump spark ignition, and so on. Perhaps the most desirable point about the whole equipment as compared with some others is that the engine and propeller run equally well in both directions, and may be reversed while running.

The Economy Piston.

The water end of any steam pump as manufactured to-day is an expensive article for the purchaser; the piston has been left in its primitive state for many logical reasons that are entirely conclusive to the satisfaction of the pump and packing



manufacturers, but this for the user means continued loss and expense. The pump manufacturer claims that no improvement is necessary, as the pumps are easily sold, regardless of any saving or advantages to the purchaser; the packing manufacturer obviously does not favor any improved form of piston that will save the packing and materially lessen his sales.

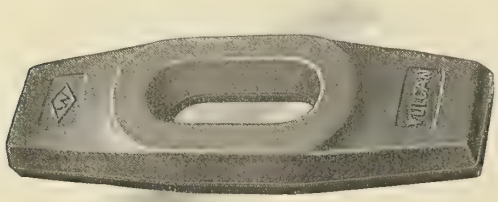
This piston, made by the Economy Piston Company, 268 Midland avenue, Montclair, N. J., is shown in the left side of the illustration, packed and in normal condition ready for

insertion in the pump cylinder, all parts being contracted smaller than required in order that the piston may be easily placed. When the packing wears, it is forced out against the walls of the cylinder, the piston becoming as tightly packed as desired, and this may be continued until the expansion parts are expanded to the limit, and the packing worn to almost nothing, as shown in the right half of the figure.

This is done by simply removing the cylinder head, loosening the nuts on the collar bolts, and screwing the collar bolts right-handed. The conic segments travel away from the piston body, thus forcing out the cup segments, which in turn force out the bull ring and packing. When adjusted to tightness, the lock nut is tightened and packing is held in expanded position, thereby performing the office of new packing, which may be continued as often as desired until all of it has disappeared.

Drop-Forged Planer Clamps.

A stiff, substantial drop-forged clamp or clamping head for use on planer, lathe, drill press or milling machine, has been developed by J. H. Williams & Company, Brooklyn, N. Y. Made from a strong, tough grade of carefully selected steel and submitted to a special process after forging, increases their strength and stiffness. These forgings, time-saving and



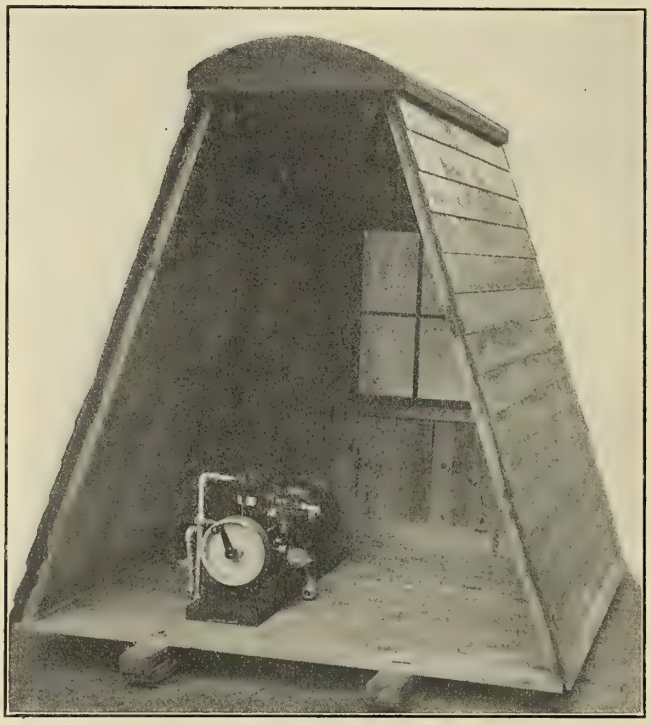
effective, will make possible an assorted, handy lot of clamping devices as commercially available as a machine bolt, and should prove valuable additions to all machine shop equipments. They are made in lengths of 4, 6 and 8 inches, with widths from 1 3/16 to 2⅜ inches, and a maximum thickness of 1⅛ inches. The slots are 1⅜ to 2 13/16 inches long, and 11/16 to 13/16 inch wide.

A Unique Electric Generating Plant.

The illustration shows a novel portable dynamo house with direct-connected electric generating set. The outfit is constructed to carry 10, 20 or 30 lights, according to the candlepower and voltage. When operating at a speed of 850 revolutions per minute, the engine develops 1½ horsepower, and the dynamo supplies a current of 104 volts pressure. The electric generator has a capacity of 7.5 amperes normal load, and will carry a maximum load of considerably above this amount. The equipment is arranged to operate with illuminating gas or natural gas, and also has the carbureter arranged to use alcohol or gasoline (petrol) as a fuel, as well as oil, the heated air entering the carbureter from an open T at the ends, this fitting being slid over the exhaust pipe, and the air entering the T being warmed before reaching the carbureter, by coming in contact with the exhaust pipe, thereby more easily vaporizing the alcohol or oil fuel.

For constant load, with a definite number of lights, no regulator is necessary, the outfit running with practically constant speed, and an extra flywheel and a flexible coupling taking up the impulses of the engine very satisfactorily. For a variable load, the portable house is provided on the left hand side with 50 cells of storage battery of 8 or 10 ampere-hour capacity, this being sufficient to give good regulation and supply a reserve current for night lamps in homes or for extra current during heavy load; taking up current when the set is operating at less than full load. The voltage is held practically constant by the battery floating on the line, 26 cells only being necessary when 52-volt lamps are used, and the engine and dynamo set is run at a correspondingly lower speed, having, of course, at this lower speed a correspondingly lower kilowatt capacity.

For boat lighting this set is satisfactory, as well as for charging automobile batteries, a double cylinder engine of larger capacity with a larger generator in this case being desirable. For store lighting, where a constant number of



lights are required continuously, a very satisfactory result is obtained without a governor of any kind. But for a variable load the storage battery plant is necessary, to take up the inequalities due to the increased speed when lamps are turned off. With the battery in parallel with the engine-generator set and lighting circuit, the load and speed are held constant on the gasoline motor, even though the number of lights is varied.

The portable house is necessary where the fire underwriters object to gasoline being used as a fuel in buildings insured, but where gas is employed, a plant of this character can readily be employed in a basement of any kind. Similar outfits are in extended use in Germany and England, and without doubt will be largely used in this country. The foreign sets are, however, far more costly, and are all equipped with governors and cast iron bases common to both engine and dynamo.

Where a greater output is necessary, two 1½-horsepower cylinders are mounted together, giving a total of 3 horsepower, with a very even turning moment, there being two explosions for each revolution of the dynamo. In this case twenty 16-candlepower lamps may be operated. At this output the muffler entirely deadens the explosions, as in the most quiet running automobiles. For larger kilowatt capacity for charging electric automobiles, and similar service, two 3-horsepower cylinders are used, with a generator of 2½ kilowatts, capable of operating over 40 incandescent lamps. These outfits are designed for portable or stationary service, and are supplied by the Buffalo Mechanical & Electrical Laboratory, Erie County Bank building, Buffalo, N. Y.